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DOING YOUR BIT

By C. P. McDonald

WHEN you have struggled and shouldered the load of the job you have chosen to fill, and you're looking ahead for the turn in the road but it's always "just over the hill," keep plodding and plugging and pushing along, don't stop by the wayside and quit, but carry your cross with the snack of a song, content to be "doing your bit."

The way may be long and the road may be rough and ambition may seem on the wane, but just bear in mind that the world is half bluff in the game of catchpenny and gain; contribute your share as you doggedly plod, by backing your brawn with your wit; the world never tortures a man with a prod when it knows he is "doing his bit."

Just grin as you bump the rough edges of life and whistle a tune of content; a fight worth the winning is sweetened with strife, and a scrapper has naught to repent; buck up and pluck up and forge right ahead with backbone and muscle and grit; rewards are potential, when all's done and said, for the fellow who's "doing his bit."

Chain of Rocks Remodeled Boiler Plant

By H. F. GAUSS

Eight water-tube boilers were completely remodeled at a cost of $5.35 to $6.71 per boiler horsepower. Coal- and ash-handling facilities were installed, stokers replaced hand-firing, superheaters were added to the boilers, and a number of other interesting features were introduced.

THE boiler room serving the low-service pumping station at the Chain of Rocks, St. Louis, Mo., recently remodeled and made a modern plant, embodies numerous features that will bear description. The boiler house is a brick building 145 ft. long by 61 ft. wide, and originally contained eight hand-fired downdraft boilers set in batteries of two each. Of these boilers, six were of the National water-tube type, each containing 3650 sq.ft. of heating surface, and two were O'Brien boilers of the Heine water-tube type, each containing 2500 sq.ft. of heating surface. The total horsepower at normal rating based on 10 sq.ft. of heating surface was 2690.

There is no occasion to dwell at length on the condition of the plant before it was remodeled; suffice it to say that it was not what it should have been, either from an operative or from an economical viewpoint. Fig. 1 gives an idea of the plant before reconstruction and also of how the remodeling was executed. Instead of scrapping the old boilers and buying new ones, which procedure might have been warranted in view of the fact that the National boilers were about 21 years old, and had seen 24-hour service for much of the time, it was decided to thoroughly rebuild them, making an appreciable saving in the cost of reconstruction possible. Originally, the drums on all eight boilers were made with lap-riveted seams. New drums with double-riveted butt-strap joints were provided, all questionable tubes were replaced and the boilers rendered practically new.

The handhole-cover plates in the sectional cast-iron tube headers of the National boilers were originally placed on the outside with the arches on the inside; the covers were held in place by 1¼-in. steel bolts and tight joints secured by means of asbestos gaskets. On frequent occasions these bolts had failed in pulling up, and the handhole plates had dropped off. To eliminate this danger, the apparatus shown in Fig. 5 was designed for milling out a seat on the inside of the handholes in the header boxes. The cover plates are now placed on the inside and the arches on the outside, causing the boiler pressure to assist in holding the cover plates in place instead of tending to push them off.

The cost of dismantling and reconstructing the boilers is given in the accompanying tables.

RECONSTRUCTION OF TWO OF THE NATIONAL BOILERS

Cost of Dismantling	Total	Per Horsepower
Labor on settings	$263.24	$0.361
Labor on boilers	107.56	0.148
Total	$370.80	$0.509
Cost of Reconstruction		
Labor on boiler	$512.59	$0.70
Cost of drums	1,176.00	1.61
Boiler cost	$1,688.59	$2.31
Labor on settings	$1,355.40	$1.86
Material for settings	858.09	1.18
Lime and cement app.	26.00	
Setting cost	$2,239.49	$3.04
Cost of boiler and setting	$3,928.08	$5.35

RECONSTRUCTION OF THE TWO O'BRIEN BOILERS

Cost of Dismantling	Total	Per Horsepower
Labor on settings	$329.51	$0.66
Labor on boilers	254.51	.51
Total	$584.02	$1.17

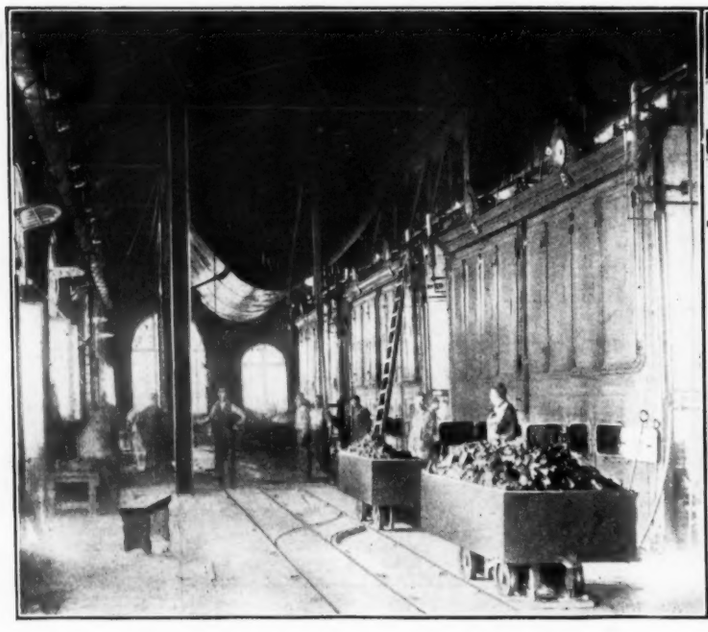


FIG. 1. CHAIN OF ROCKS BOILER PLANT UNDER RECONSTRUCTION

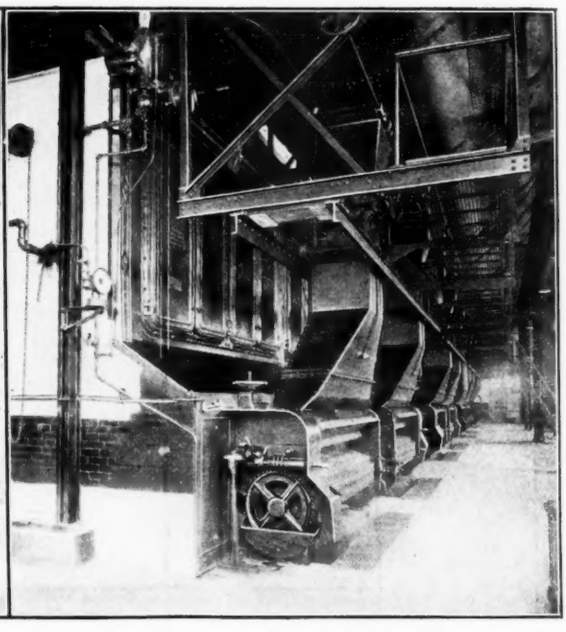
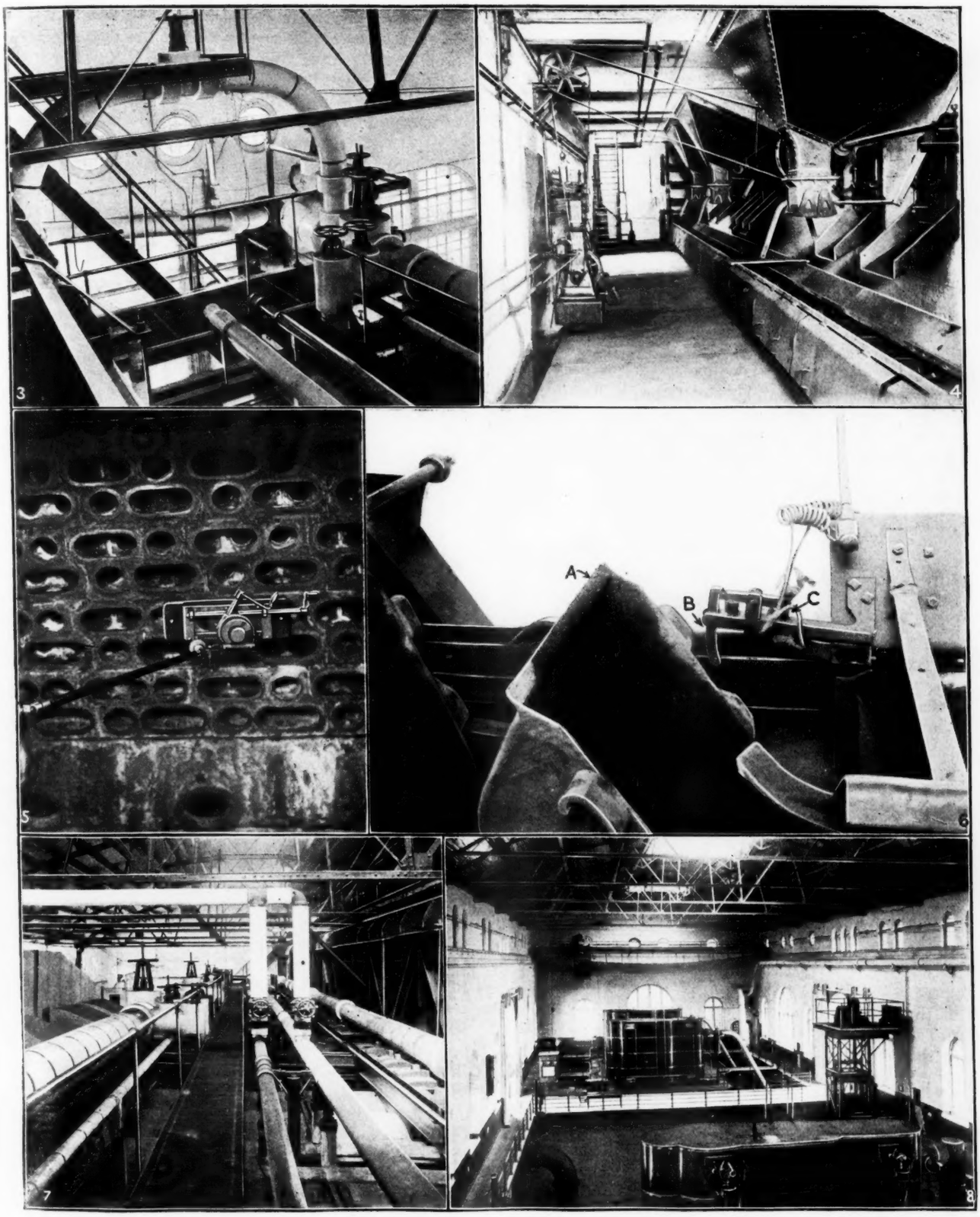


FIG. 2. SAME BOILER ROOM REMODELED



FIGS. 3 TO 8. VIEWS AT CHAIN OF ROCKS BOILER PLANT AND ENGINE ROOM, SHOWING CONVEYOR DETAILS AND PIPING ARRANGEMENTS

Fig. 3—Valved cross-connection between headers. Fig. 4—Conveyor, sifting hoppers and ash doors. Fig. 5—Milling machine used on handholes. Fig. 6—Electric device through which tilted bucket will shut down conveyor motor. Fig. 7—Walkway over boiler tops. Fig. 8—Shows the two headers entering engine room

Cost of Reconstructing

Labor on boiler	$771.59	$1.54
Cost of drums	1,027.00	2.05
Boiler cost	$1,798.59	$3.59
Labor on settings	$1,057.29	$2.12
Material for settings	500.46	1.00
Lime and cement, app.	26.00	.....
Setting cost	$1,583.75	$3.12
Cost of boiler and setting	$3,382.34	$6.71

These costs do not include milling out the seats on the inside of the header boxes.

At the time this work was done, new boilers would have cost $12 per horsepower, or a total of $32,280. The total cost of reconstructing the eight boilers was $15,166. A saving of $17,114 was thus effected.

All of the boilers were equipped with chain-grate stokers. The ratio of heating surface to grate area was 48 to 1 for the National and 45 to 1 for the O'Brien boilers. This low ratio was adopted for the reason that the stack was small for the load, and a high rate of combustion was not possible. Chain grates were chosen in preference to other types of stoker, in view of the fact that bituminous screenings from southern Illinois mines were to be burned, and the practical grate for this purpose is the chain grate. Superheaters were installed in all boiler settings. In the National boilers the superheaters were placed between the top row of tubes and the bottom of the drums. A total of 467.1 lin.ft. of 2-in. superheater elements were provided for each, consisting of 27 return-tube sections. This is equivalent to 1.28 ft. per horsepower, and the superheat guaranteed was 125 deg. with steam at 150 lb. gage pressure. The space between the top row of the tubes and the bottom of the drums in the O'Brien boilers was not sufficient for superheaters, and for this reason they were placed in the combustion chambers, a comparatively new location for superheaters. The installation has been entirely successful, and the high temperatures encountered have had no serious effect on the material of which the superheaters are made. For each boiler 220.5 lin.ft. of 2-in. superheater elements were provided, consisting of 18 return-tube sections. This is equivalent to 0.88 lin.ft. per boiler horsepower, and the superheat guaranteed was 150 deg. with steam at 150 lb. gage pressure. Owing to the fact that these boilers were located farther from the engine room than the others, it was thought best to carry a higher degree of superheat in them.

For convenience in cleaning out the combustion chamber, an 18 x 19-in. door in the base of the bridge-wall was provided, through which the soot and fly-ash accumulation could be shoveled directly into the ashpit. Without such a door this accumulation would have to be shoveled over the bridge-wall and much of it would drop on the rear of the chain grate. It has been found that when this is done, the air spaces in the grate become choked up with the fine ash, which is wet down to settle the dust, sticking to the links.

Under the front part of each stoker, through which fine unburned coal is apt to fall as the grate moves forward, a liberal sheet-iron sifting hopper is located. This hopper is provided with a clamshell gate arranged to dump the siftings into the bucket conveyor in the tunnel.

Fig. 10 is a sectional elevation of a National boiler showing the stoker, superheaters, door in bridge-wall, siftings hopper, ashpit and bucket conveyor. Fig. 9 is a sectional elevation of one of the O'Brien boilers with the superheater in the combustion chamber instead of under the drums.

Special attention was paid to placing the various appliances for operating the boilers in as accessible positions as possible. The damper control was brought to the front by means of a simple system of levers. The draft gage was so located that with his hand on the damper lever the fireman could have his eye directly on the gage. Both gage and damper lever were so placed that without moving from either, the fireman could reach the speed-control device for the stoker. The steam-flow meter was supported on a cast-iron bracket on the front buckstay, about 7 ft. above the floor, within plain view of the fireman while operating the stoker, and the illuminated-dial steam gages were placed above the boilers, but on the same side as the other apparatus mentioned. Lastly, the water column with its combination high- and low-water alarm was attached to the drums on this side also, and the whole system was made as convenient for operation as possible. The object in this arrangement was not to encourage laziness on the part of the fireman, but efficiency, for generally when a man has to walk all the way around his boilers to get at the damper control, and when the draft gage is placed some distance from the damper levers, the damper is frequently left in one position and no attention paid to the effect of its adjustment on the draft. When the

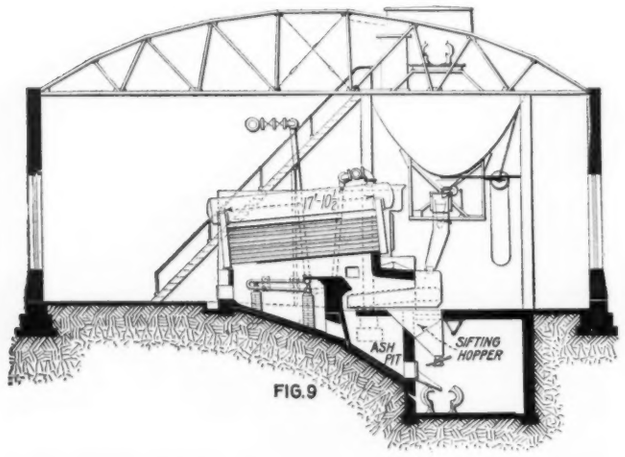


FIG. 9. SUPERHEATERS IN REAR OF O'BRIEN BOILER

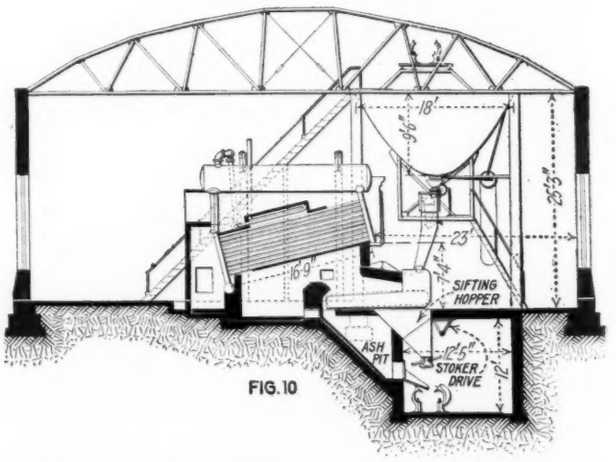


FIG. 10. SECTION THROUGH NATIONAL BOILER

steam-flow meter is placed in an inaccessible place where it is difficult to read the figures on the dial and hard to get at and make adjustments, it is neglected and soon becomes useless. On the other hand, it was intended that one fireman should operate all the boilers used on a single watch, and to do this successfully it was essential that the apparatus be arranged as described. Fig. 2 is a front view of the boilers, showing the apparatus.

A conveyor and ash tunnel were constructed in front of the ashpits, extending the entire length of the boiler

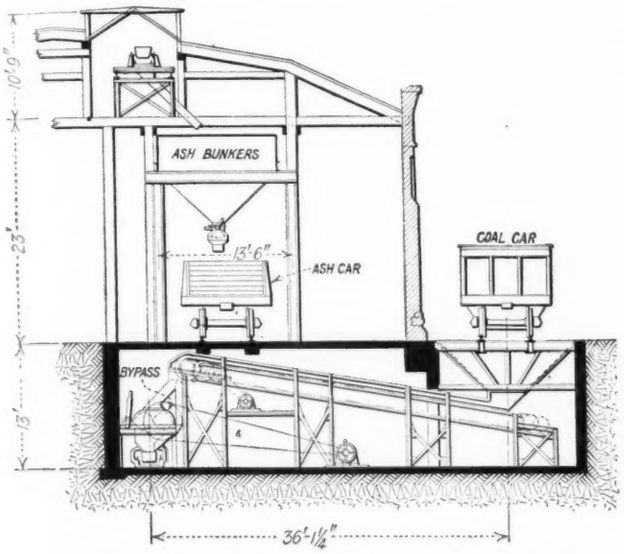


FIG. 11. COAL- AND ASH-HANDLING FACILITIES

room and below the ash bunkers in the coal shed. This tunnel is 12 ft. 5 in. wide by 12 ft. high and 180 ft. long.

The tunnel accommodates a Stephens-Adamson bucket conveyor and is sufficiently wide to permit ashes being hoed from the ashpits into the conveyor conveniently, and also contains the stoker engine and emergency motor. Fig. 4 is a photograph taken in the tunnel showing the conveyor, stoker engine, sifting hoppers, ash doors and stairs leading from the boiler room into the tunnel. For convenience in dragging ash into the conveyor from the ashpits, permanent hoe rests were installed before each set of ashpit doors. Heavy hoes can thus be used that dig down into the ash by their own weight.

When the plant was put in operation, considerable trouble was experienced due to the buckets failing to right themselves after passing over the lower conveyor sprocket wheels, with the result that they fouled the horizontal guide runners, and on one occasion the sprocket-wheel housing was torn from its anchorage and serious damage was done. To overcome this danger, an electrically operated knockout switch was arranged by means of which a bucket on failing to right itself would shut down the conveyor motor. The arrangement is shown in Fig. 6, in which *A* is a protruding bucket that is on the point of coming in contact with the latch *B* and in turn closing switch *C*. When the switch is closed, a current will operate a cutout switch and stop the conveyor before damage is done.

An unloading track hopper was provided just outside the coalhouse, and arranged to receive coal from dump-bottom cars placed on a switch running parallel to the main tunnel. A flight across conveyor delivers coal from hopper either into a crusher or directly upon the main conveyor. When it is necessary to crush coal, the crusher in turn delivers its product upon the main conveyor.

The crusher is of the toothed type, motor-driven, and designed to break up the coal to 2-in. nut size. Fig. 11 is a sectional elevation showing the unloading hopper, cross conveyor, crusher and main conveyor.

To secure a bunker capacity of 600 tons, it was necessary to utilize all the available headroom. A roof lantern was constructed the entire length of the boiler room and over that portion of the coal shed included, and the conveyor run between top and bottom members of the main roof trusses. To do this successfully required careful laying out and erection, but the necessary storage space was secured and the apparatus is entirely satisfactory. Steel bunkers of the parabolic type supported on steel columns were installed and provided with gates, automatic scales and spouts for each stoker. In addition, three extra gates were provided—one between each battery—by means of which coal can be run out of the bunkers and into the conveyor through manholes

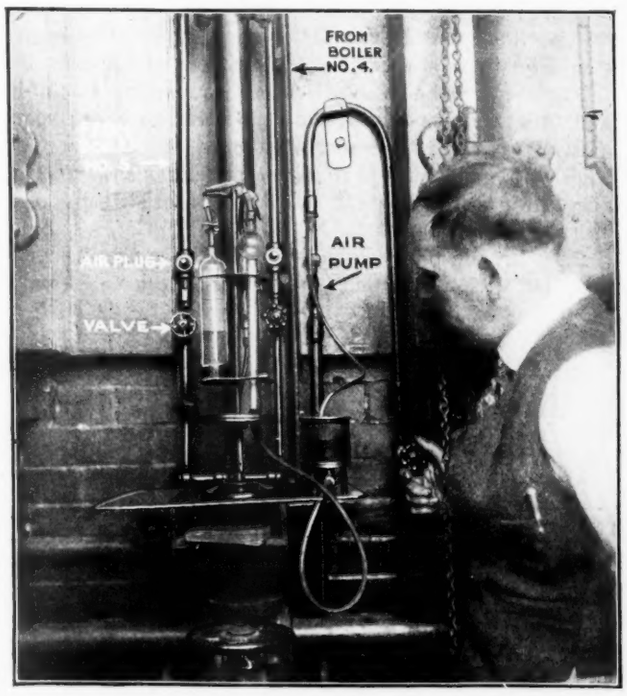


FIG. 12. SINGLE-CHAMBER ORSAT SERVING BATTERY OF BOILERS

in the tunnel roof, which provision will serve in case of bunker fires.

A separate section of the bunkers is reserved for receiving siftings from the hoppers under the front ends of the stokers and is arranged so that the siftings may be spouted into coal trucks and distributed to the stoker hoppers without passing through the automatic scales to be weighed a second time.

Three steel and concrete-lined ash bunkers, each of 22 tons' capacity, were installed in the coalhouse under the north end of the conveyor, and at the present rate of operation there is an ash-storage capacity for five

days' running. The reason for installing three bunkers was to provide three discharge gates so spaced that an ash car could be completely filled with one spotting on the track under the hoppers. Provision was also made for discharging the ashes into industrial trucks.

The concrete lining protects the steel from the corrosive action of the wet ashes and also prevents the ashes from sticking to the sides. It was necessary to place the ash bunkers off center from the conveyor and employ steel chutes for directing the ashes into them. The method is entirely successful, and no trouble has been experienced in the handling of the ashes.

To facilitate the operating and maintenance of the equipment, liberal galleries, accessible by means of iron stairs and permanent iron ladders, were provided around the motors, transmission machinery, switches and valves. Fig. 3 is a picture taken from the top of one of the National boilers, showing these galleries at the north end of the boiler room. A walkway shown in Fig. 7 was constructed over the tops of the boilers for the entire length of the boiler room. It also shows the new steam header of loop design consisting of a 10-in. pipe connected to each superheater by 5-in. branch pipes. The header is carried on the columns that support the National boilers and on structural iron supports resting on the side walls of the O'Brien settings. The loop is completed with a 6-in. header carried on the columns.

Fig. 3 shows the valved U-bend connecting the 10-in. and 6-in. headers at the south end of the boiler room, and Fig. 8 the two headers entering the engine room. The 10-in. header is carried on a gallery below the operating floor, and the 6-in. header is supported by brackets on the engine-room wall.

Each branch pipe connecting a boiler to the header is provided with an automatic stop and check valve and a gate valve. Gate valves are provided in the 10-in. header between each battery, also before the first and after the last boiler, making the system perfectly flexible. All these valves are extra-heavy with steel bodies, bonnets and yokes; the stems are of rolled monel metal, the wedge and seat rings are of monel metal and designed for 250 lb. steam pressure and 150 deg. F. superheat. All the fittings are steel, and expansion is cared for by the use of long-radius flexible bends.

Each battery of boilers was equipped with a hand-operated single-chamber Orsat apparatus arranged to sample gases from either boiler. The sample is drawn from the outlet in the setting just before the dampers. Each apparatus is furnished with a water aspirator for drawing a sample, and a complete analysis can be made in about two minutes. In Fig. 12 the engineer is in the act of drawing a sample, his hand being on the valve admitting water to the air pump or aspirator. The gas passes down the pipe from the boiler outlet, through the filter tube and into the measuring pipette, and is drawn out through the leveling bottle into the top of which the suction side of the air pump is connected. This connection consists simply of a rubber cork on the end of a piece of rubber tubing that can be quickly inserted in a hole in the top of the leveling bottle. After the air in the pipes and apparatus has been expelled and a fair sample obtained, the aspirator valve is closed and the analysis made in the usual way.

In a later issue of *Power* a description of the new stack and breeching that were found necessary will be given, in addition to the economical improvement in operation secured by the changes made. The design and construction of the station was under the direct supervision of L. A. Day, chief mechanical engineer of the St. Louis Water Division.

Emergency Transformer Connections—II

By G. P. ROUX
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Special transformer connections are discussed for obtaining single-phase and polyphase voltage compensation, multivoltages and phase transformation. Article 1 appeared in May 15 issue.

IT IS well known that in three-phase to two-phase transformation by means of the Scott connection, in order to obtain a balanced secondary voltage in each phase, it is necessary to have one of the transformers provided with an 86.6-per cent. tap, this feature involving a special transformer not always available, especially on short notice.

The same results can be obtained with two standard transformers having the proper ratio of transformation and capacity, connecting their primary in *T* as shown in Fig. 1. The two secondary windings will, however, deliver an unbalanced voltage, or 2300 volts in phase *A* or that of the main transformer, and only 1991.8 volts in phase *B* corresponding to the teaser transformer.

Phase *B* can be boosted the difference of 308.2 volts by means of two small pole-type transformers, as shown in the figure, thus doing away with the special transformer and its 86.6-per cent. connection.

Referring to Fig. 1, one of the boosting transformers has its primary connected across 1991.8 volts and, having a ratio of transformation of 10 to 1, will supply to its secondary coils connected in series 199.2 volts, which, added to the incoming voltage, gives 1991.8 + 199.2 = 2191 volts. The second boosting transformer is connected with its primary across 2191 volts, and having a ratio of transformation of 20 to 1 with the two secondary coils in parallel, further boosts the voltage 109.5 volts, making a total of 2191 + 109.5 = 2300.5 volts, for practical purposes equal to the voltage of Phase *A*.

In selecting the boosting transformers for this style of connection it is important to see that their combined capacity is equal to at least 13.4 per cent. that of the phase to be boosted, as their secondary must carry the full-load current of the phase, providing two-thirds of the capacity for the first and one-third for the second transformer.

For other voltage adjustments the boosting transformers can be connected in different ways. For in-

stance, if the desired voltage is to be 2191 volts instead of 2300, phase *B* can be boosted to deliver this voltage, as already shown, with only one transformer, and phase *A* can be bucked 109.5 volts with another transformer, making the voltage of phase *A* 2190.5 volts and phase *B* 2191 volts, or practically equal.

With transformers having either regulating taps or adjustable ratio of transformation, practically any voltage adjustment can be obtained with proper connections. An extremely close voltage adjustment is not so very important in the case of emergency connection, the continuity of service being of greater importance than a slight unbalancing of voltage, which, in a motor installation, would not affect the operation.

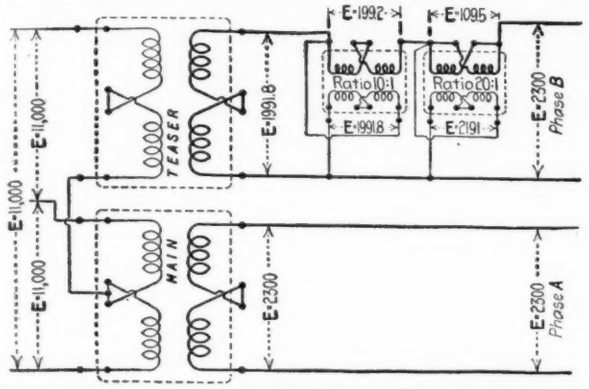


FIG. 1. FOUR TRANSFORMERS CONNECTED TO GIVE A TWO-PHASE TO THREE-PHASE TRANSFORMATION

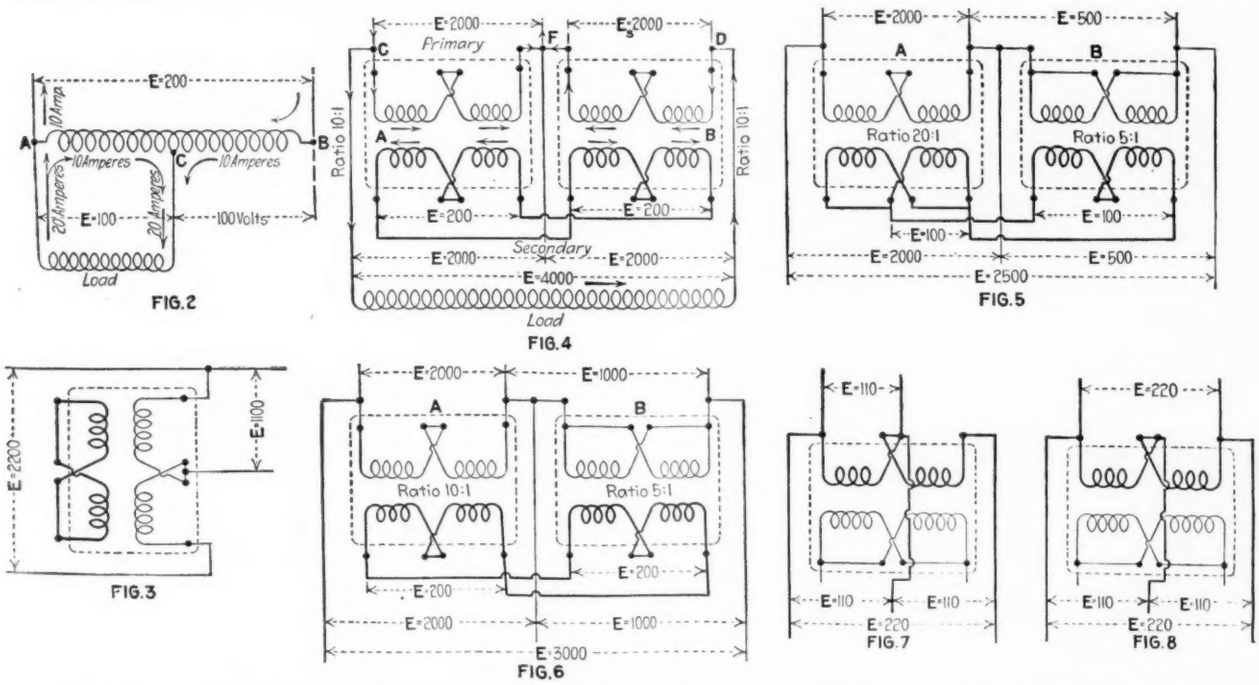
Even for permanent operation, a few volts difference in the primary circuit is of little importance as it will affect the customer's voltage a very small percentage. The effect of the boosting transformers on the phase to which they are connected is also inappreciable in so far as regulation and power factor are concerned. Assuming the boosting transformers to have a regulation of 2 per cent., the primary voltage would be reduced $(199.2 + 109.5) \times 0.02 = 6.17$ volts, or $\frac{6.17}{1992} =$ 0.3 per cent. of the primary voltage of phase B, Fig. 1.

Standard compensating coils or auto-transformers consist of a magnetic circuit with but one coil provided with taps distributed so as to permit the auto-transformation desired. Such apparatus are therefore single-coil transformers which can be compared, in voltage adjustment, to a rheostat in a direct-current circuit; they are also called economy coils.

The well-known principle of the auto-transformer needs only a brief description. It consists of a single coil, Fig. 2, acting simultaneously as primary and secondary. For a ratio of 2 to 1 a tap is brought out at the middle point of the winding, the primary current of, say, 10 amp. at 200 volts flows in the coil. Assume that the primary current, 10 amp., flows from line *B* at 200 volts, which is reduced to 100 volts at the middle point of the coil where the secondary line *C* taps off. The current flowing in the primary section *BC* of the coil will induce 100 volts in the secondary section *AC*, which will also supply 10 amp. into line *C*, making a total of 20 amp. and 100 volts on the secondary side. In the return line 20 amp. flows to terminal *A*, where it is divided between the two branches of the circuit, 10 amp. flowing back to the primary through line *D* and 10 amp. to the secondary *AC* of the auto-transformer. Connecting the primary to terminals *AC* and the load to *AB* gives a step-up instead of a step-down auto-transformer.

In the absence of auto-transformers, ordinary pole-type transformers of sufficient capacity in their primary windings can be used as step-up or step-down compensators and are especially adaptable where the ratio of transformation does not exceed 1 to 2. They can be used for polyphase as well as for single-phase lines.

A typical single-phase compensator connection is shown in Fig. 3 for stepping up from 1100 to 2200 volts



FIGS. 2 TO 8. DIFFERENT SCHEMES OF VOLTAGE TRANSFORMATION WITH ONE AND TWO TRANSFORMERS

or stepping down from 2200 to 1100 volts by means of a pole-type transformer, using only the primary winding, whose current-carrying capacity must necessarily be equal to that of the circuit to be boosted.

In all compensator connections where ordinary two-coil (primary and secondary) transformers are used, only the primary winding is utilized as a single-coil auto-transformer, and it is advisable to connect the secondary coils in multiple in order to reduce the impedance and magnetic leakage between the coils.

Compensator connections for voltage adjustment of single-phase lines and of different ratios of primary to secondary are shown in Figs. 4, 5 and 6, using in each case two single-phase transformers.

In Fig. 4 is shown a 2000-volt transformer *A* with its two primary coils in series and connected across a 2000-volt circuit, and also connected to one side of the primary of a similar transformer *B*. The ratio of the transformers is 10 to 1, therefore, if 2000 volts is impressed upon the primary of transformer *A*, 200 volts will be induced in its secondary. If the low-voltage winding of transformer *A* is connected to that of transformer *B*, an electromotive force of 2000 volts will be induced in the high-voltage winding of the latter, which, when

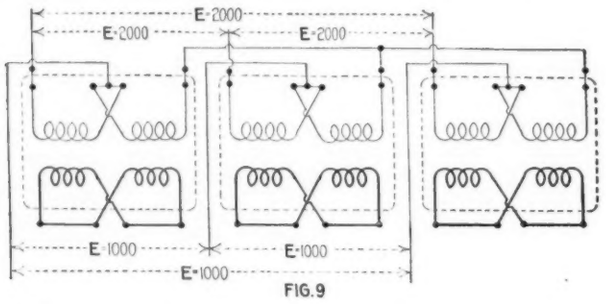


FIG. 9

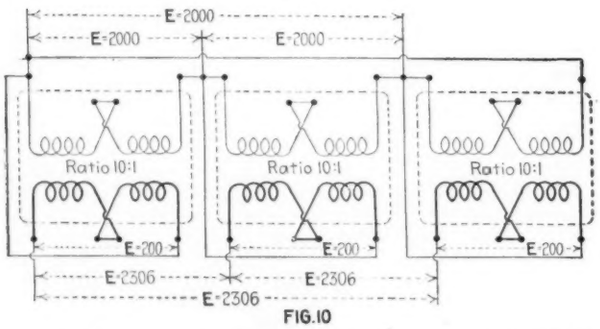


FIG. 10

FIGS. 9 AND 10. THREE-PHASE VOLTAGE TRANSFORMATION WITH THREE TRANSFORMERS

connected in series with the primary winding of transformer *A*, as shown in the figure, will give 4000 volts across the outside legs of the circuit. The 4000-volt circuit is from terminal *C* through the load back to terminal *D*, through the high-voltage winding of transformer *B*, where 2000 volts is added to the primary pressure, and back to the source of electromotive force. By taking a third tap from between the transformer, 2000 volts may be obtained from either transformer, as shown.

Fig. 5 is the same as Fig. 4 except that the low-voltage coils of transformer *A* have been connected in parallel to give a ratio of 20 to 1, and the high-voltage windings of transformer *B* connected in parallel to give a ratio of 5 to 1. If the high-voltage winding of transformer *A* is connected to a 2000-volt circuit, 500 volts will be produced in the high-voltage winding of transformer *B*, thus making it possible to obtain three voltages—2500, 2000 and 500—with the connections shown.

The connection shown in Fig. 6 is also the same as that in Fig. 4 except that the high-voltage coils of transformer *B* have been connected in parallel, giving this transformer a ratio of 5 to 1 and making it possible to obtain three voltages; namely, 3000, 2000 and 1000 volts.

Auto-compensation can equally be obtained from the low-voltage windings of transformers, as shown in Figs. 7 and 8. In Fig. 7 a 110-volt line is connected to one section of the 220-volt winding of a transformer, making possible a 110-220 volt three-wire circuit. Fig. 8 shows a 220-volt line connected to a 220-volt transformer winding, with a connection taken from the middle point; this also provides a 110-220 volt three-wire circuit. This latter connection is the same as the ordinary balancing coil on a 110-220 alternating-current three-wire system. In Figs. 7 and 8 the idle winding, or in this case the high-voltage winding, which consists of two coils, is connected in multiple for the reasons previously given.

It would be impossible to enumerate here all the possible connections that could be made in answer to emergency requirements. Each one can, with a little study of the situation, be laid off to meet the problem at hand, the number of combinations being limited only by the capacity and number of coils in the transformers available.

To step-up or step-down line voltage of polyphase systems, standard transformers can be connected to meet most of the practical requirements as imposed by operating conditions. In Fig. 9 three-phase compensator connections, ratio 1 to 2, are shown to either decrease the line voltage from 2000 to 1000 volts or increase it from 1000 to 2000 volts, the transformers being connected in star.

Boosting Line Voltage

For boosting three-phase line voltage, connections as per Fig. 10 can be used to great advantage to compensate for line drop caused by excessive load, low power factor or insufficient size of conductors. The combination shown in the figure with 10: 1 transformers gives a boost of 15.3 per cent. One or more transformers with their secondaries in series with the line can be used and so connected to each phase as to compensate for any drop found in practice, when transformers are properly selected and their connections combined to secure the expected results.

The various systems of voltage boosting previously described find a convenient and advantageous application for the economical supply of service to rural or outlying districts that can be reached from the end of a city feeder. The voltage can be raised to a convenient value for transmission to greater distances, thus greatly reducing the cost of installation and line equipment.

Emergency Scott connections have been described and shown in Fig. 1. With the delta-cross system of connections, it is also possible to obtain from a three-phase transformer installation, simultaneously, three-phase and two-phase circuits by bringing out a 50-per cent. tap from the secondary of one transformer. This will

give a voltage in one phase of only 86.6 per cent. that of the voltage across the other phase, which is boosted to full secondary voltage by means of the two small transformers connected as shown in Fig. 11 and as already explained for the boosting of one phase of the emergency Scott connection, Fig. 1. The total capacity of the boosting transformers must be equal to at least 6.7 per cent of the total capacity of the two-phase load in order to carry the total current of one phase of the two-phase system. The three-phase connections remain the same as in the case of the delta-connected transformers and need no explanation.

A complete description of this useful system of connections has been given by the author and will be found in the August, 1915, Proceedings of the American Institute of Electrical Engineers.

The primary of the transformers shown in Fig. 11 can be connected either star or delta and wound for any

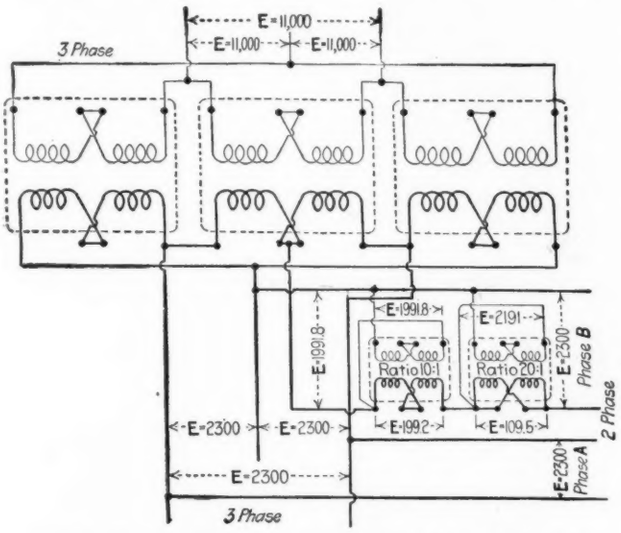


FIG. 11. TWO-PHASE CIRCUIT TAKEN FROM A THREE-PHASE TRANSFORMER CONNECTION

voltage. Two-phase and three-phase generators can be connected to the secondary of a system of transformers connected delta-cross and operated in parallel satisfactorily, supplying either phase load or stepping up to three-phase and vice versa.

A great number of combinations of voltage transformations and adjustments can be effected with single-phase transformers properly connected and selected as to their capacity, number of coils and voltage. Multiphase and multivoltage transformations can also be obtained by special connections adequately made. In all cases some preliminary study must be given to the requirements, as several solutions are generally available and good judgment is essential in making the final selection.

Riley Stoker Rocker Ash Dump

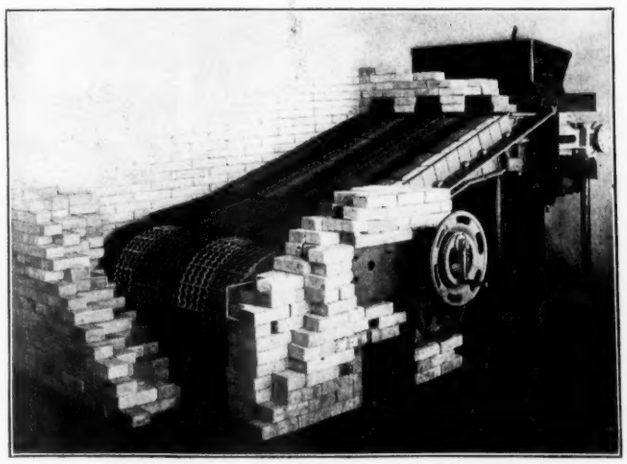
One cause of trouble and expense with underfeed-stoker operation has been the formation of clinker at the back end of the furnace and on the bridge-wall. Similar formations of clinkers on the side walls have also been experienced to the detriment of the brickwork, in that portions of the brick lining were likely to be torn off whenever a clinker was detached by barring.

Side-wall clinkers have been practically eliminated in the Riley stoker by the adoption of moving retort sides, which continually shear off and break up any clinker formation while it is soft. A similar idea has been applied at the bridge-wall in the shape of a new rocker dump, built by the Sanford Riley Stoker Co., Ltd., Worcester, Mass. The constant agitation of this dump automatically discharges the ashes and prevents large clinkers from forming at the lower end of the furnace. As a result, the cleaning periods are decreased from one in 4 hours to one in 24 to 48 hours.

Referring to the illustration, the dump plate is connected to a trunnion that is fastened to the end of the corresponding side bar. The outer end of the rocker plate is carried by a roller, attached to the rack that formerly supported the older apron-dump. As the overfeed sections move back and forth, the same motion is given the rocker dump. The motion at the hinge is of course horizontal, but that at the outer end is tangential to the point of contact with the roller, and at all positions of the rack is very nearly vertical. The resultant motion of the dump plate is about as if it were operating around an axle situated below the plate. The amount of opening between the bridge-wall and the rocker dump is adjustable by means of the racks, which can be moved either forward or back, the same as with the apron dump.

The dump is designed to fit on the standard stoker without changes other than the removal of the old-style apron parts and overfeed grates.

The design of the overfeed section just above the dump plate has also been improved, with the object of reducing the possibility of serious burning at this point, while eliminating all large exposed vertical surfaces with



NEW ROCKER DUMP, SHOWING RELATIVE MOVEMENTS OF THE ROCKER PLATES

small air supply. This is assured by ribbed flat grate bars having a large number of smaller air openings. This feature also provides an adequate supply of air for the combustion of coke at this point of the furnace, the air supply being under the control of the overfeed damper.

Greater ease of installation and removal of parts is also an object in reducing maintenance labor by an arrangement that permits the removal of these parts without disturbing other portions of the furnace.

Tom Hunter, Hoisting Engineer

By WARREN O. ROGERS

Hunter shows me a quadruple compressor engine that upon test with 243 lb. steam pressure consumed but 11.23 lb. of dry steam per indicated horsepower. The feed water, due to the arrangement of feed-water heaters, went to the boilers at a temperature of 335 deg. F.

AS WE left the office of the Copper Range Consolidated Co., we saw over to the right, alongside of the railroad track, a building that looked as if it might be a power plant of some kind. We therefore made our way toward it, and upon entering the room we were confronted by the largest air compressor I had ever seen. Hunter, however, did not show any surprise; in fact, he knew what we were to find there.

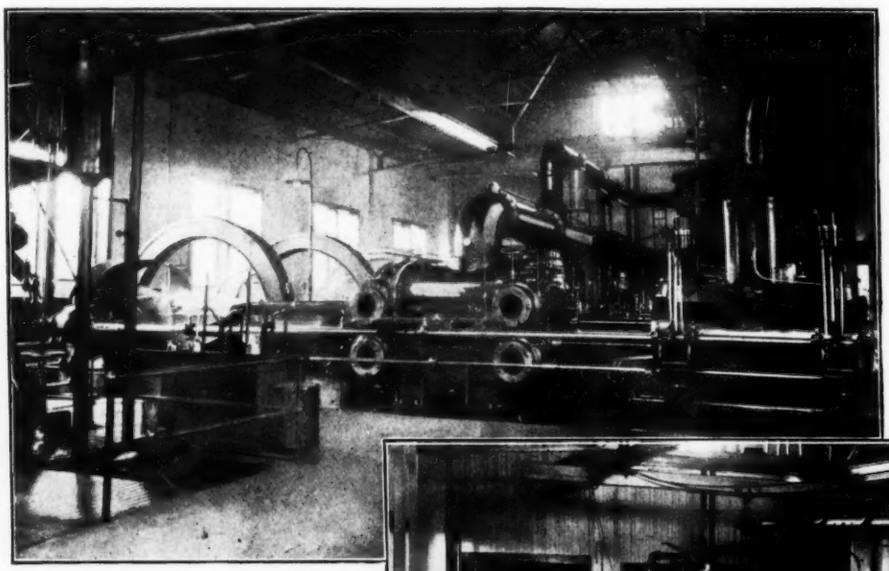


FIG. 1. SIDE VIEW OF QUADRUPLE AIR COMPRESSOR

FIG. 2. ANOTHER VIEW OF THE QUADRUPLE AIR COMPRESSOR WITH HEATERS IN THE REAR

"You have seen considerable in the technical papers recently regarding higher steam pressures, and as a matter of fact plants are being built or planned to carry from 275 to 350 lb. steam pressure and as high as 250 deg. superheat, but here is a machine that, when built about nine years ago, was designed to operate at 300 lb. steam pressure. When a test was made about 17 months after it was put in operation, it proved a record-breaker on low steam consumption and holds it yet so far as I know.

"As I remember, the original guarantee made by the builders (Nordberg Manufacturing Co.) was that the engine should develop 180,000,000 ft.-lb. of work in the steam cylinders for each 1,000,000 heat units used and that it should compress 9000 cu.ft. of air per minute at 80 lb. running at 76 r.p.m. with a pressure of 300 lb."

"Well, did the machine come up to expectations," I asked.

"It did and it didn't," replied Hunter. "You see, the machine was there all right, but the boilers gave trouble after a pressure of 250 lb. was reached. It was necessary to run with about 243 instead of 300 lb. pressure as intended. The test at the higher pressure was called off, of course, but it was decided to make one under the actual daily running conditions to see what the actual performance of the unit might be. That meant that the test was carried on not only with reduced steam pressure, but also with fewer revolutions and a lower air pressure."

"It is some compressor," I remarked, while busy getting the camera in position for taking a picture (Fig. 1).

"It's a quadruple machine, with the four cylinders placed horizontally side by side. The sizes are 14½, 22, 38 and 54 in. for the high, two intermediate and the low-pressure cylinders, respectively; the stroke is 48 in. The high-pressure cylinder is fitted with poppet valves, but Corliss valves are fitted to the intermediate cylinders, and the low-pressure one has special rotating disk valves arranged in the heads. The cranks are so placed that the high-pressure one crosses the outer dead-center, the second intermediate the inner, the low-pressure the inner and the first intermediate crank the outer

dead-center in the order named. There are three flywheels on the shaft, as you see, also the eccentrics for operating the Corliss valves and the air valves on the compressor cylinders. The valves of the high-pressure steam cylinder are actuated by an offset crank that is driven by the crankshaft, which also drives a crankshaft on the low-pressure end to operate auxiliaries and the low-pressure cylinder valves."

We were told by chief engineer, Mr. Toms, that the high-pressure cylinder was jacketed, the steam coming from the drip of the main separator. It was then passed through a reducing valve to the first reheater and a second reducing valve to the second and third reheaters, after which it was directed through a float trap to one of the feed-water heaters.

"The feed water," explained Hunter, as we walked toward the far end of the room, "is gradually heated by steam that has done some work and that is delivered to the heaters, each succeeding supply being at a higher temperature than the other. Feed water goes to a preheater, the supply being controlled by a float valve, pumped through an economizer to the boilers. The engine operates condensing through a surface condenser."

Fig. 3 shows a diagram of the steam piping of the feed-water heating system.

As we walked past the crankshaft end of the machine, Hunter observed: "You see, the air cylinders are fitted with Corliss valves and the first-stage compression cylinders are connected to the high- and low-pressure cylinder and the second-stage cylinders are connected to the intermediate steam cylinders. Air comes to the first-stage cylinders through a pipe leading to the outside of the building, and it is discharged to a receiver before going to the distributing system."

The engineer told us that the whole machine took up a space 45 x 56 ft., exclusive of the intercooler and skimming tank. Below the floor were the receivers, auxiliary pumps, oil separators and traps. The condenser and preheater extended from the basement through the floor into the engine room.

"This engine made a remarkable record on the 10-hour test that was run. Let me see," and Hunter pulled

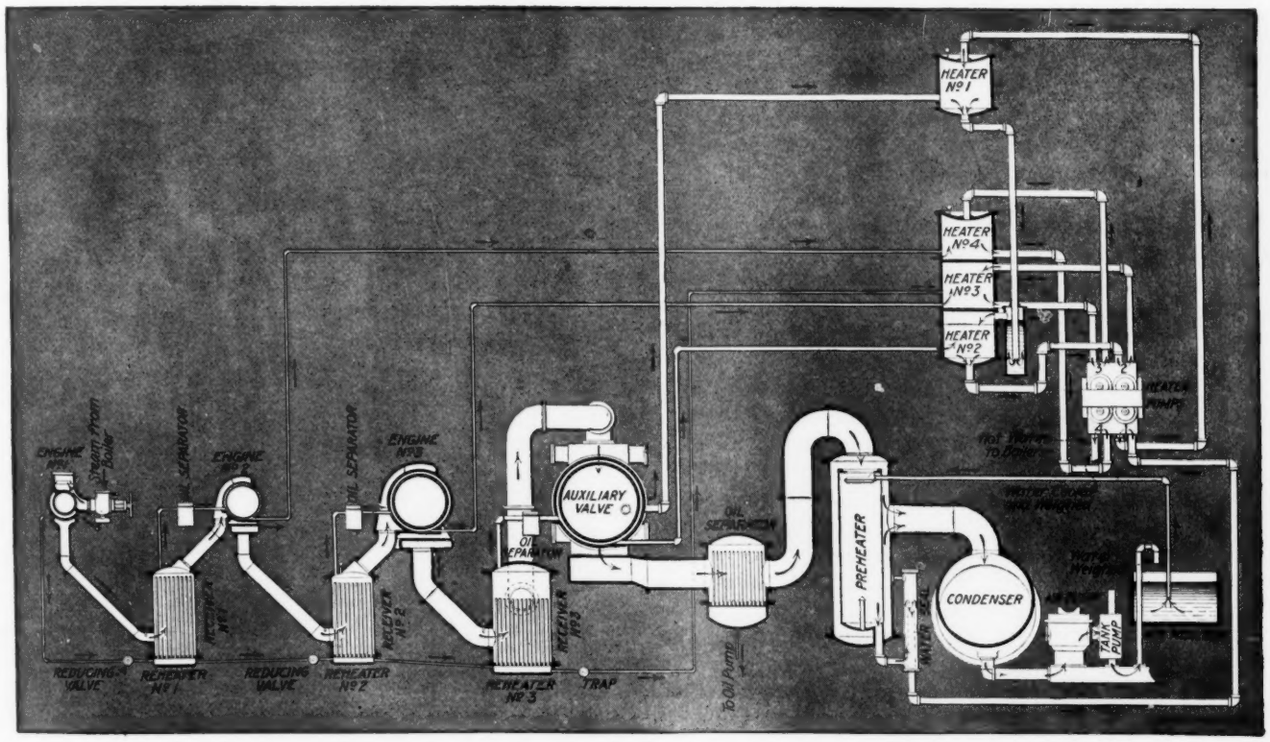


FIG. 3. DIAGRAM OF THE STEAM AND PIPING OF THE FEED-WATER HEATING SYSTEM

and it is heated by steam from the low-pressure cylinder. Water from the preheater is pumped into an elevated heater where it is heated by steam taken from the low-pressure cylinder. The water from the elevated heater flows by gravity to another heater, which receives steam discharged from the low-pressure jacket, which comes from the third receiver. Water from the second heater is pumped into a third heater, which receives the second intermediate cylinder jacket water and also the water that is discharged from a trap on the reheater line. The water is again pumped from the third heater to a fourth, where it is heated by steam drawn from the first intermediate jacket from the first receiver. From this last heater the water is out his ever-ready data book. "I believe that I have some figures here on that test. Here they are. Steam pressure, 242.8 lb.; vacuum in condenser, 25.95 in.; temperature of feed water leaving No. 4 heater to the boiler, 334.5 deg.; r.p.m., 56.9; total indicated horsepower, 989.7. The total horsepower used in the air cylinders was 883.2 and with 11 hp. consumed by the auxiliaries made the friction load of the engine 95.5 hp. The mechanical efficiency of the engine and compressor was 90.35 per cent. The machine consumed 11.23 lb. of dry steam per indicated horsepower per hour and 12.58 lb. per brake horsepower."

After chatting with the engineer, we left the plant and started toward No. 2 Champion mine shaft.

The Throwing on of Belts

By JAMES F. HOBART

Hundreds of men have been injured when throwing belts on revolving pulleys. Although the practice is dangerous, some suggestions are given as to the right and wrong method to employ in doing the work.

THE practice of throwing belts off and on running pulleys is bad, but probably as long as belts are used, the practice will be continued. Therefore, as long as we will do something bad, why not use the best means of doing the work with the least possible risk? Belts over 8 in. wide should never be thrown or "run" upon their pulleys. Such wide belts should be put together in belt clamps. By following this method a wide belt will never be damaged during the putting-on process, something which is likely to happen when a wide belt is run upon its pulleys after having been laced or otherwise fastened. To be sure, belts as wide as 24 in. have been run on with no apparent damage to them, but one side of the belt will be stretched during the process.

When a belt is to be run on, the pulley speed should be reduced to a very slow rotation if possible. The slower the better. Some workmen become so expert that there is scarcely any limit to the high pulley speed at which they can throw on a belt, but there is a greater risk to both man and machine as the speed at which the belt is thrown is increased.

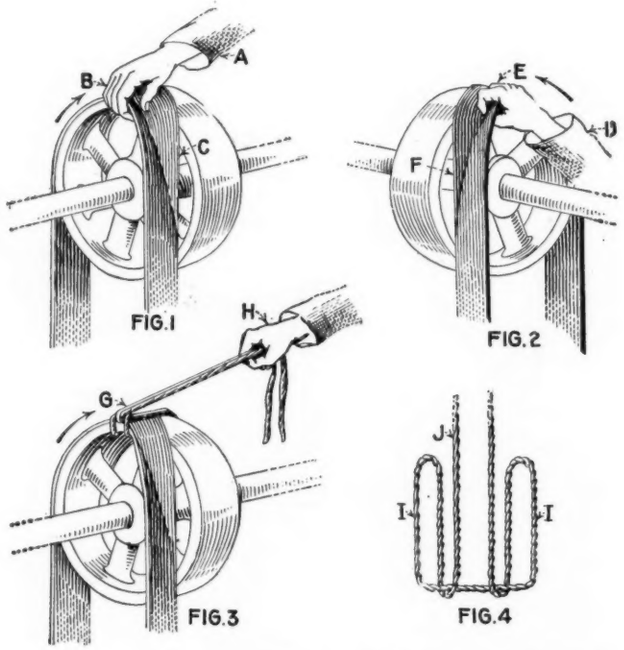
Aside from the risk to the man—that he may slip or make a miscalculation and get caught in the belt or the pulley—there is also the danger of injury to the belt when the speed is high. When a high-speed belt is thrown on without slacking the speed, it is evident that as one pulley is at rest, the belt must slip upon either one or the other of the pulleys for the length of time required to get the shaft up to speed from a state of rest. The slower the speed of the moving shaft the less slip and the less belt wear there will be in getting the other pulley up to speed.

There is a right as well as several wrong ways of handling a belt. Fig. 1 shows the way that should be always followed save when the location of the pulley forbids. As shown, the workman should always stand on the far side of the pulley so as to pull the belt toward him. There are several reasons for this. First, a man can pull much more than he can push. Also, should he slip, he would move away from the belt and from danger, whereas were he to push the belt into place and slip, he might fall against the belt or the pulley.

As shown at *A*, Fig. 1, the workman should post himself behind the pulley, then gather up the belt on the "on" side of the pulley and guide it over the pulley as shown at *B*. Here is where the knack comes in. The workman must balance the belt upon the pulley so accurately that it will not slip off the "on" side of the pulley, in which case it would simply flop over to the side where the workman was stationed. At the same time, while balancing the belt on the face and edge of the pulley, the man must exert strength enough, at just the right time, to make the belt climb up the rest of the way toward the top of the pulley.

Sometimes this can be accomplished by a quick snap and pull on the belt, but where the load to be started is heavy, it is sometimes necessary for the workman to let the belt slip under his hand for a considerable distance, he keeping the belt balanced during the time that the belt and pulleys which were at rest are getting velocity enough to allow the belt to climb to the top of the pulley without slipping off one side or the other. Here, again, is where the great advantage of running slowly is seen.

A method of handling a belt which is wrong in almost every way is shown in Fig. 2. To begin with, the workman at *D*, pushing on the belt at *E*, is at a great disadvantage as regards the strength he can exert.



FIGS. 1 TO 4. METHODS OF THROWING A BELT

He is in danger should he slip or should the belt get away from him, in which case he might become entangled in it and perhaps be caught and carried around the shaft.

Another thing that is not right is shown at *F*, where one edge of the belt is folded underneath. This makes it almost impossible to run the belt upon its pulley, especially where the belt is quite tight and there may be a considerable load on it. The correct way of placing a belt is shown at *C*, Fig. 1, where it is placed smoothly against the edge of the pulley rim. The belt should never be allowed to get into the position shown at *F*, Fig. 2. If it does, the workman should straighten it out before trying to throw it on.

Tying on a belt is sometimes resorted to when a very wide or a particularly heavy or heavily loaded belt is

to be handled. The writer does not recommend this method, nor does he believe in it, and he never practices it except in case of emergency when there is no time to apply the belt clamps.

This method, like the others, may be made worse or better as the workman goes about it. When tying on must be done, procure a small cord, one which will break before it will injure the belt. A piece of "marline," such as is used for tying up bales of paper at the mill, is a safe cord to use. But, as shown by Fig. 3, do not tie the belt. Just slip the bight of the cord through under the rim of the pulley, as at *G*. Pass the free ends of the cord through the bight and pull the ends tight, as at *H*, at the same time working the belt as far as possible upon the pulley and holding it there by means of the cord.

When ready, have the pulley started very slowly, and as the belt runs upon the face of the pulley, slacken the hold on the cords at *H*, and as the belt runs on, let go and the cords will usually fall to the floor. In case the cord catches and winds up on the shaft, it should be removed at the first opportunity, lest it catch on something.

An enlarged view of the manner in which a cord should be placed around both belt and pulley rim is shown in Fig. 4. The loops *II* pass around the parts mentioned, and the ends *J* are passed through the bight, or loop and then drawn as tight as possible. Do not make the mistake of tying a knot in the cord. If it is impossible to hold it as the belt strain comes on, then try again and give the cord a turn around both belt and rim and hold the ends in the hand as before. The added friction of the cord will then enable a man to hold the heaviest belt that should ever be treated in this manner, and the danger of his being caught is practically eliminated.

The Electrical Study Course—Voltmeter and Ammeter Connections

The connection of the voltmeter and ammeter is considered. It is shown that the same instrument movement may be used to measure either volts or amperes, it being only a matter of how they are connected in the circuit.

IT WAS pointed out in the previous lesson that the movement used in a voltmeter or an ammeter is the same, the difference in the two instruments being in the way they are connected to the circuit. The movement is connnected in series with a high resistance when used to measure volts and in parallel with a low resistance when used to measure current. It is general practice to use about 100 ohms resistance in series with the movable coil of the voltmeter for each volt of scale range; that is, an instrument that would indicate 100 volts on full-scale reading will have approximately $100 \times 100 = 10{,}000$ ohms resistance, or an instrument that will indicate 150 volts on full-scale reading will have about $100 \times 150 = 15{,}000$ ohms resistance. This value will vary slightly with different instruments. Instruments that have approximately 100 ohms for each volt-scale reading are what may be termed the general commercial type of instrument used in general practice. However, there are types of voltmeters that have a very high resistance of 1,000,000 ohms. Such instruments are generally used for measuring high resistance such as the insulation resistance of electrical apparatus.

In Fig. 1 is shown an instrument system similar to that described in the previous lesson, connected in series with a resistance *R* across the two conductors of a circuit. Assume that the resistance of the movable coil is 10 ohms and that a resistance *R* of 9990 ohms is connected in series with this coil; then the total resistance of the instrument will be 10,000 ohms. If we mark the 0 position on the scale and then apply a voltage $E = 10$ across the instrument and resistance *R* in series, a current $I = \frac{E}{R} = \frac{10}{10{,}000} = 0.001$ ampere, will be set up through the coil. This current will create a turning effort against the spiral springs, which let us assume will cause the pointer to take the position indicated at 10. By marking this position and then increasing the voltage to 20, a current $I = \frac{E}{R} = \frac{20}{10{,}000} = 0.002$ ampere will be set up through the coil. This increased current through the coil will increase the turning effort and cause it to take a new position, say at the division marked 20 on the scale.

In this type of instrument the turning effort produced by the coil is directly proportional to the current flowing through it; that is, if the current in the coil is doubled the turning effort is doubled, consequently the distance that the needle will move across the scale will be double. Owing to slight construction defects which are almost impossible to overcome, the foregoing is not absolutely true. If it were, all that would be necessary to do in dividing the scale, would be to determine the zero and maximum points and divide the distance between these two points into the desired number of divisions. However, on the better grade of instruments, to eliminate any slight errors that may occur, a number of cardinal points are determined by actual tests, such as in the figures 0, 10, 20, 30, etc., up to 100. The scale is then removed, these divisions are divided, and the scale worked in by a draftsman. After this has been done and the scale replaced, the instrument may be used to measure volts on any direct-current circuit up to the limit of the instrument scale.

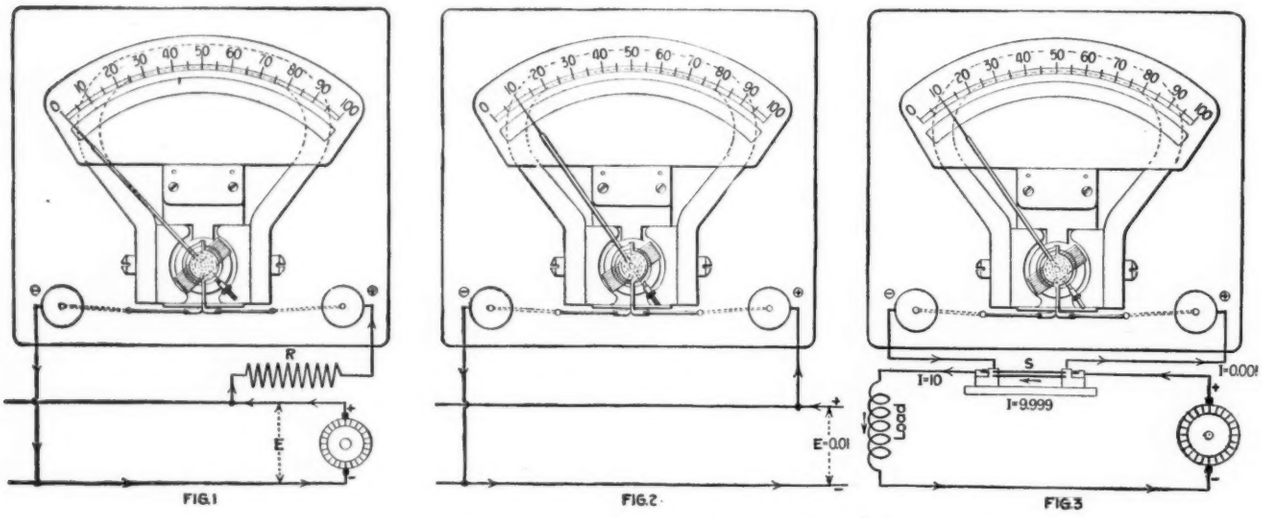
In a large percentage of voltmeters the resistance is made up in a convenient form and placed inside the instrument case. In some portable types the resistance is made up separately and must be connected in series with the instrument when it is connected to the circuit.

If we had followed out our calculations for the current through the instrument at different 10-volt di-

visions, it would have been found to be 0.001, 0.002, 0.003, etc., up to 0.01 ampere for the 10-, 20-, 30-, up to the 100-volt division, respectively. Hence, we see it was not volts that actually caused the pointer to move, but the current that was made to flow through the coil by the voltage impressed upon it and the resistance. It does not make any difference how the current may be obtained through the coil, it will move the pointer to the position corresponding to the value of the current in the coil. For example, suppose that we remove the resistance R, as in Fig. 2, and connect the instrument to a circuit that has a voltage $E = 0.01$. Then the current through the coil, which has a resistance of only 10 ohms, will be $I = \frac{E}{R} = \frac{0.01}{10} = 0.001$ ampere. This value corresponds to that obtained in Fig. 1, with 10 volts and 10,000 ohms resistance, consequently the pointer will throw to the same position in Fig. 2 for 0.01 volt as it did in Fig. 1 for 10 volts. In Fig. 1, when the instrument was connected to 100 volts, the current through the coil was $I = \frac{E}{R} = \frac{100}{10{,}000} = 0.01$ ampere. In Fig. 2 this value would be obtained when 0.1 volt was impressed on the instrument; that is, $I = \frac{E}{R} = \frac{0.1}{10} = 0.01$ ampere. In the former case the voltmeter would indicate that 100 volts was impressed across the circuit, where in the latter there is only 0.1 volt. Instruments used to measure such low voltages or currents are called millivoltmeters or milliammeters, a millivolt being one-thousandth of a volt, and a milliampere one-thousandth of an ampere. Many of the instruments are constructed to read in the thousandth part of a volt or ampere.

When we measure amperes, the instrument, as previously mentioned, is connected in parallel with a low resistance. Such a connection is shown in Fig. 3. The section of the circuit that the resistance is connected across is called a shunt. The shunts are usually constructed of a special alloy called managnin, the resistance of which is practically constant through a wide range of temperature. If the shunt S, in Fig. 3, is made of such a resistance value that when 10 amperes is flowing through the circuit 9.999 amperes will flow through the shunt and 0.001 ampere pass through the instrument's coil, then the current value in the coil will be the same as when, in Fig. 1, the instrument was connected to a 10-volt circuit, which caused the needle to be deflected to the division marked 10. Consequently, if the instrument is operating under the conditions in Fig. 3, the pointer will move to the scale division marked 10, but instead of indicating volts the instrument will indicate amperes. The division of the current is proportional under all conditions. If the current is increased to 100 amperes, 99.99 amperes will flow through the shunt and 0.01 ampere will pass through the instrument, and the pointer will be deflected to the 100 scale division. Thus it is evident that the same movement may be used for measuring either volts or amperes.

The layout of the study problem from the previous lesson is given in Fig. 4. The total resistance R in the circuit is the sum of the resistance of the armature R_1 the external resistance R_2 and the battery resistance R_3,



FIGS. 1 TO 3. SHOW VOLTMETER AND AMMETER CONNECTIONS

that is, $R = R_1 + R_2 + R_3 = 0.15 + 3.3 + 0.05 = 3.5$ ohms. The voltage E_3 that the dynamo will have to develop to cause a current I of 30 amperes to flow through the resistance R of 3.5 ohms is $E_r = RI = 3.5 \times 30 = 105$ volts; 105 volts is what the dynamo would have to generate if resistance was the only opposition in the circuit, but in this case the battery has an open-circuit voltage of $E_b = 75$, which must also be overcome, therefore the dynamo will have to generate a total pressure of $E = E_r + E_b = 105 + 75 = 180$ volts. In the armature due to resistance there will be a voltage drop of $E_a = R_1 I = 0.15 \times 30 = 4.5$, and the available volts at the armature terminals are $E_1 = E - E_a = 180 - 4.5 = 175.5$. The voltage necessary to overcome the ohmic resistance of the battery is $E' = R_3 I = 0.05 \times 30 = 1.5$, and the total voltage E_3 applied to the battery is the sum of that necessary to overcome the open-circuit volts and that to cause the current to flow through the internal resistance, or in this case $E_3 = E_b + E' = 75 + 1.5 = 76.5$ volts. The volts drop

across the resistance R_2 is $E_2 = R_2I = 3.3 \times 30 = 99$. Then $E = E_a + E_2 + E_3 = 4.5 + 99 + 76.5 = 180$ volts, which checks with the total previously calculated.

The watts loss in the armature is $W_1 = E_aI = 4.5 \times 30 = 135$; watts expended in the resistance R_2 are $W_2 = E_2I = 99 \times 30 = 2970$; watts supplied to the battery are $W_3 = E_3I = 76.5 \times 30 = 2295$ watts, and the total watts $W = W_1 + W_2 + W_3 = 135 + 2970 + 2295 = 5400$. W also equals $EI = 180 \times 30 = 5400$ watts, which checks with the foregoing. The total kilowatts $= \frac{W}{1000} = \frac{5400}{1000} = 5.4$, and the electrical horsepower $= \frac{W}{746} = \frac{5400}{746} = 7.2$ horsepower.

The foregoing calculations very clearly show the necessity of having the voltage of the circuit that a battery is to be charged from approximately the same as that of the battery if the charging is to be economically done. In this problem the pressure was 99 volts too high, consequently we had to put resistance enough in the circuit to use this pressure up, or 3.3 ohms. In the resistance R_2 2970 watts were expended which did no useful work and therefore represent a direct loss that might have been saved by having the voltage of the dynamo approximately that required by the battery.

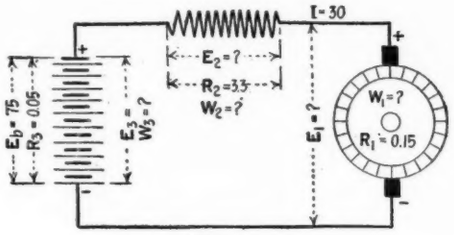


Fig. 4

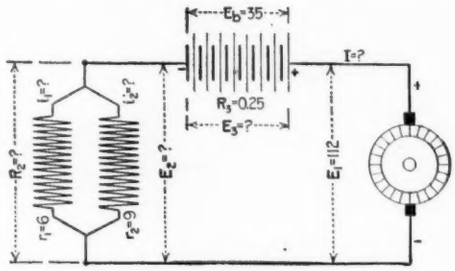


Fig. 5

FIGS. 4 AND 5. CONNECTIONS FOR CHARGING STORAGE BATTERIES

In Fig. 5, if the voltage E_1 across the armature terminals, when the current is flowing in the circuit, is 112 and the open-circuit voltage E_b of the battery is 35, find the value of the current in the circuit, the volts E_3 impressed on the battery terminals, volts drop across R_2, current in r_1 and r_2 and the total watts, kilowatts and electrical horsepower delivered into the circuit by the generator.

Pressure Reducing and Regulating Valves

BY J. C. HAWKINS

The advantages of reducing valves are pointed out, and the method of piping several types is shown. Some practical information regarding their operation is given.

THERE are instances in almost every power plant when it is necessary to provide a supply of steam considerably lower than boiler pressure for use in heating systems, cookers, dry kilns, and for many manufacturing processes. In some cases this low-pressure steam may be supplied from the exhaust of the main engines or auxiliaries, but generally some live steam from the boilers must be used, at least to supplant the exhaust at certain periods.

In using live steam in a heating system, it is well to keep the pressure down to a few pounds, because it eliminates the unnecessary strain on the radiators and piping, and as the temperature of steam at two or three pounds or even less is sufficient for heating, a higher pressure and temperature is unnecessary.

In some manufacturing processes heat from live steam is required and the nature of the work is such that only a certain heating temperature is permissible, and the pressure must be varied to suit the temperature requirements. If the steam is to be supplied from high-pressure boilers, in order to insure a supply at a steady lower pressure, some type of reducing valve is necessary, whereby the reduced pressure will be maintained constant under the varying demands. This valve must be self-regulating, and in order to guard against overpressure, which might result disastrously to some part of the equipment, it must be dependable to cut off the supply from the boilers when necessary.

The drop in pressure due to passing saturated steam through a reducing valve does not necessarily indicate a loss of energy because the friction through the valve which causes the drop in pressure transforms the energy into heat which tends, first, to evaporate any entrained moisture that may be present and, second, to superheat the dry steam to a temperature above that corresponding to the reduced pressure. The amount of superheat depends upon the quality of the saturated steam entering the valve and the range of pressure reduction. Where the pressure is reduced to a few pounds, the steam is superheated considerably, thereby reducing the condensation in the line.

There are a number of different types of reducing valves designed to maintain a constant pressure, nearly all of which depend on the low pressure for the actuating medium to control the amount of valve opening and consequently the amount of steam passing through them. These valves may be divided into those having a single unbalanced seat valve and those having double-seat balanced valves. They may also be divided into

those having metal or rubber diaphragms and those without diaphragms. Some are controlled directly by the low pressure, others by the low pressure acting on an auxiliary or pilot valve and diaphragm, controlling the main valve by either high or reduced pressure. They may be divided again into those having springs and weights to control the main valve opening and those controlled by a piston. It is impossible within the scope of this article to enumerate every different type of reducing valve, but a few of those representative of each type are given.

In installing a reducing valve there are certain methods that it is necessary to follow if the best results are to be obtained. The direction in which the steam should flow through the valve is important and is usually stamped on the side of the body or indicated by an arrow, and it may enter either above or below the disk, depending on the type of valve.

Most reducing valves are designed to be placed in a horizontal pipe, although with some modifications many types can be used on vertical pipes; others may be used in any position without change. Practically every type of reducing valve should be provided with a bypass and valves by means of which it may be taken out of service for repairs when necessary. Fig. 1 shows a convenient method of piping up the valve. The two gate valves *A* and *B* are used to reduce the steam friction and eliminate water pockets, but the valve *C* should be a globe or angle valve so as to more closely regulate the steam pressure while the regulator is out of commission. The bypass can be made of smaller pipe if desired, which will permit the globe valve to be opened wider in regulating. There should be a steam gage connected to the low-pressure side near the valve, also one on the high-pressure side unless the pressure is known. The gage lines may be run to any convenient point.

As steam expands through the valve from a higher to a lower pressure, it increases in volume; and where the reduced pressure is very low, it may be desirable to have the pipe from the low-pressure side of the valve of larger size to reduce the steam friction and maintain the carrying capacity of the line at low pressure. Many valves may be had with an increased outlet for low pressure.

Installing Reducing Valves

In installing different makes of reducing valves, some difference in the details of their application is necessary for best results, depending on whether they are self-contained, have an outside regulating line or are controlled through a separate pilot valve. Fig. 2 shows the installation of a self-contained valve in a vertical line. In this valve all the mechanism is contained within the body, and it may be placed in any position. The controlling medium is the steam in the low-pressure line. In this type of valve the main valve remains open until the pressure passing through the seat builds up in the low-pressure side sufficiently to create a pressure on top of the internal diaphragm or piston which is of greater area than the valve, and forces the main valve to its seat. The action is automatic, and the main valve remains partly open as the conditions demand.

Fig. 3 shows a diaphragm type of valve having an adjustable counterweight which holds the valve open until the pressure in the low-pressure side acting on the under side of the diaphragm, which is of greater area than the steam valve, closes it. The main valve may be of either the single- or double-seat type, as the service demands. The controlling pressure is taken from the low-pressure line through the $\frac{3}{8}$-in. line and may be taken from any point of the system at a distance from the valve which insures a more steady action of the valve in case of fluctuation of the low pressure, as might be the case when used on a steam line supplying an engine or other device using steam intermittently.

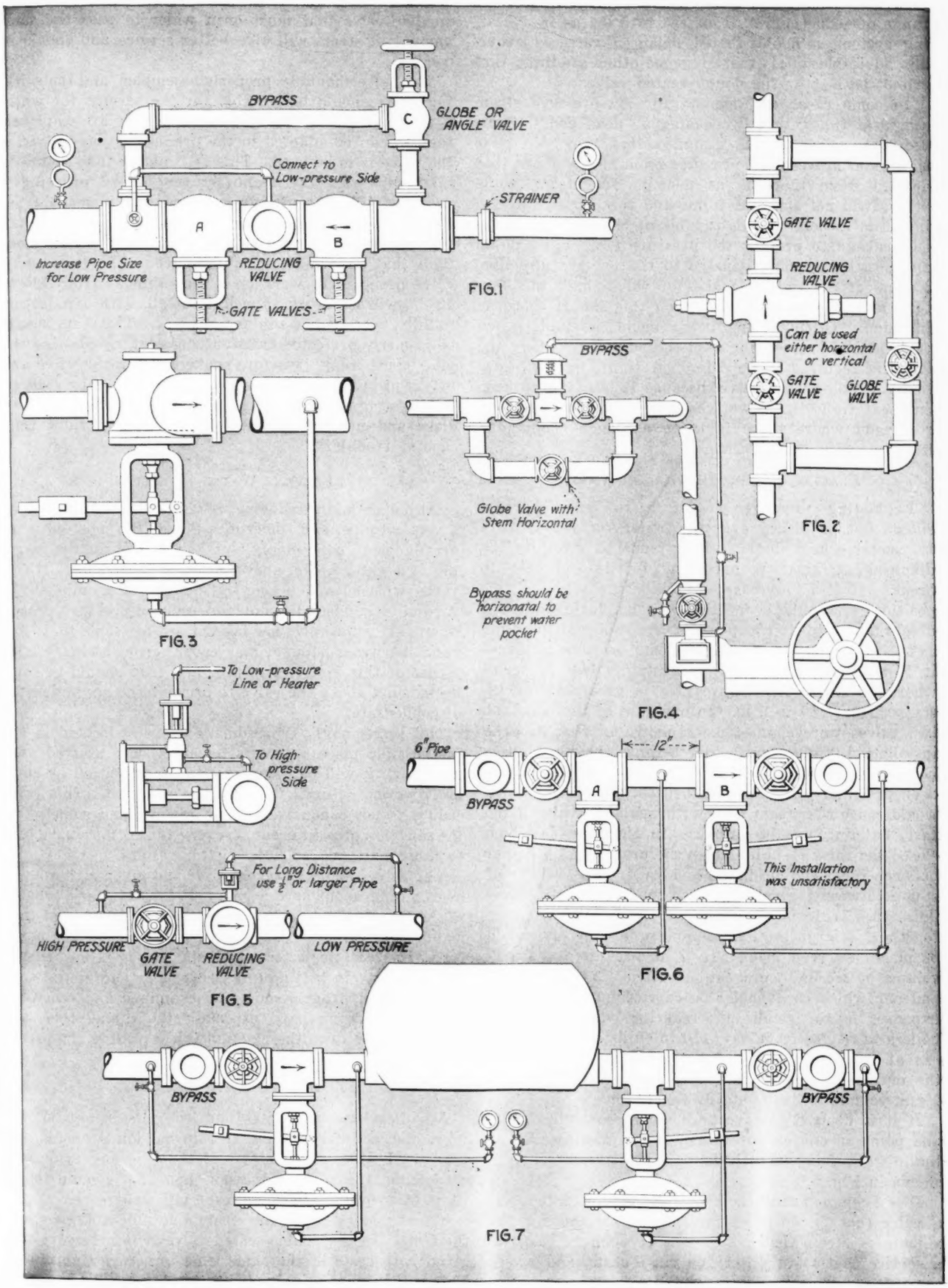
Reduced Engine Pressure

Under some conditions it is necessary to provide a pressure for small engines somewhat lower than that carried on the boilers, as for indirect heating systems and other purposes. This may be desirable where the engine is underloaded, and is done to secure a later cutoff and a more even temperature in the cylinder. Fig. 4 shows the installation of a valve for this purpose and the manner in which it is regulated. The regulating line should be connected below the throttle so that when it is closed the reducing valve will be open, and any condensation collecting in the line will flow to the separator and discharge through the drain pipe. This arrangement insures full pressure at the throttle in starting, but as soon as the pressure in the steam chest builds up, the reducing valve comes into action. The reduced pressure admitted to the cylinder is controlled by the engine governor in the usual manner.

Installing Pilot Type of Valve

Fig. 5 shows the proper method of installing a valve of another type in which the main valve is controlled by an attached auxiliary or pilot valve. In other types this pilot valve may be placed at a distance from the main valve. The main valve should be placed horizontally with the pilot valve in a vertical position, but the main line may be either horizontal or vertical, the only change necessary being to remove the bonnet bolts and rotate the valve body 90 deg. The steam from the low-pressure line acts on the pilot-valve diaphragm and causes the pilot valve to open or close, admitting or exhausting steam from the main-valve diaphragm chamber which closes the main valve by increased pressure or opens it when the pressure is overbalanced by a spring below the diaphragm. The pressure for the main diaphragm is taken from the high-pressure side near the valve, but the controlling pressure for the pilot valve may be taken from any part of the low-pressure system. In some valves of this type in which the main reducing valve is in an inaccessible location, the pilot valve may be placed at a distance, where it may be easily gotten at when a change of pressure is desired. This feature may be of considerable advantage where a frequent change of pressure and temperature is necessary, as in some manufacturing processes, and the change can be readily made at the pilot valve that is connected to the main valve through a $\frac{3}{8}$- or $\frac{1}{2}$-in. line.

It is generally conceded that for a small reduction in pressure, from, say, 50 to 30 lb., a single-seat valve, many of which have the valve unbalanced, will give the best service and is usually recommended by the manufacturer making both types. Where there is a greater



FIGS. 1 TO 7. PIPING OF SEVERAL TYPES OF REDUCING VALVES, SHOWING BYPASS ARRANGEMENT

range of reduction, as from 125 to 5 lb., as in a heating system, a double-seated balanced valve is generally advisable unless there is some other condition that cannot be met by the double-seated valve.

In some cases the demand for low-pressure steam ceases at times, thereby causing a "dead end." Some reducing valves are so designed that they will close tight, and prevent the pressure from rising above that desired when there is no demand for steam, while others will not close off tight, and the proper valve to install is the one that is capable of closing tight without leakage to prevent the pressure from building up and possibly causing damage to the low-pressure line. Not all of the reliable makes of valves have this feature, and in making the selection this should be borne in mind. Other things being equal, a single-seated valve should be used for dead-end service or where the valve is required to be closed off tight, in preference to the double-seated valve, because it is easier to keep one seat tight than two where both are on the same stem and where there is twice as much chance for leakage in the double seats.

Placing Rubber-Diaphragm Valves

Regulating valves employing a rubber diaphragm should not be placed over the boilers or where there is excessive heat, because heat tends to vulcanize the diaphragm. Make it hard and brittle and easy to break. If it is necessary to place the valve in this position, it should be of the type employing a metal diaphragm or piston in place of the rubber diaphragm, as the former is not affected by heat. In some instances it is advisable to use two reducing valves in series where the reduction of pressure is great, as for instance, from 150 to 2 lb. In one case of this kind the two valves were connected, as shown in Fig. 6. The installation was unsatisfactory because the steam space between the valves was so small that the valve *A* would open first and raise the pressure between them, which would cause the steam to flow through the valve *B* too fast, building up the pressure in the pipe *C*, which closed the valve *B*, building up the pressure still higher between them and closing the valve *A*. The volume of steam between the valves was so small that both valves pulsated. If it is necessary to put two valves near together, a large section of pipe or a receiver should be placed between them, Fig. 7, to provide a sufficient volume of steam to prevent pulsation. A better plan, and one which can usually be carried out at no extra expense, is to install one reducing valve near the boilers to reduce from, say, 150 to 60 lb., and the other one at the other end of the steam main to reduce to the desired pressure. This plan will provide enough steam volume to insure steady regulation.

If it is desired to have both valves controlled from one point at one end of the line, the one installed at the distant end may be of the remote-control type shown in Fig. 5.

It is a common fault on the part of engineers to select a valve that is too large for the service and for the amount of steam that has to pass through it. This is a service that is very hard on valve seats, and where the valve seat is too large, the lift is small and the operation cannot prove satisfactory, giving trouble in consequence of the restricted range of movement. A smaller valve that must open wider to pass the same amount of steam will give better service and should be used.

The valve should be properly assembled, and the working parts should be suitable for the service for which it is intended. If diaphragms or springs are employed, they should be adapted to the pressure range on which the valve is to be used. This is a matter that should be taken up with the manufacturer before ordering a valve, as different springs are necessary in many types for different pressures, and as a rule the valve will not regulate satisfactorily on any other range of pressure than that for which it is designed. For instance, a valve designed to work on a reduction of from 125 to 40 lb., will not work as well, if at all, with a reduction to 3 lb., without some minor changes. The seats should be properly protected from cutting first, by blowing the pipe out thoroughly before connecting up the valve and by the use of a strainer on the inlet side, as any scale or other foreign matter in the pipe may cut the seats and disks and prevent the valve from closing tight thus causing trouble.

Prevent Water Pockets

Although many reducing valves will work as well in a vertical pipe, and sometimes this is the most suitable arrangement, care should be taken to prevent the forming of a water pocket above the valve if possible. If the valve is placed with a long section of vertical pipe above it, and a sudden demand for reduced-pressure steam occurs after the valve has been closed for some time, the resulting water-hammer may cause serious damage. In a case of this kind a drip pipe and trap should be connected just above the valve to prevent the accumulation of condensate.

Not infrequently the reducing valve is located in an inaccessible place where, after it is once started and regulated, it will be given no further attention as long as it works, or until it refuses to regulate. This procedure is not conducive to best results, and sometimes the selection of a different type, one that is more adapted to the conditions, will give better results.

The valve should be taken apart and given a thorough overhauling about once a year. It is customary, where the valve is used on a heating system, to do this at the end of the season, putting it in good order for the next fall. If it is neglected until starting-up time, there may be delay in getting any needed parts, diaphragms, etc. The diaphragms should be examined and renewed when they become hard, especially the rubber type, as much depends upon their action in controlling the pressure.

Lubricating the Joints

Any bearings or joints that are outside should be lubricated at intervals, and all internal joints should be lubricated when overhauled. If there is any evidence of cutting, the seats and disks should be ground to a tight fit to prevent leakage, especially where the valve works at a low demand for steam a considerable part of the time. In the double-seated valve it is necessary to grind both seats at the same time to secure tightness. This will insure the valve being in good working order when needed and will assist in maintaining close regulation.

The Marine Water-Tube Boiler

By CHARLES H. BROMLEY

SEVERAL types of water-tube boilers are in common use aboard ship. Representative of these is the Babcock & Wilcox boiler, Fig. 3. One familiar with this boiler, the Stirling and the Heine, will quickly learn the details of any of the others. The man going into the merchant-marine service will have to handle many Scotch boilers to every water-tube boiler he will operate, for the water-tube is most widely used in the navies. Some of the more modern of merchant ships have water-tube boilers, and fast boats, such as yachts and patrols and naval vessels, also use this type.

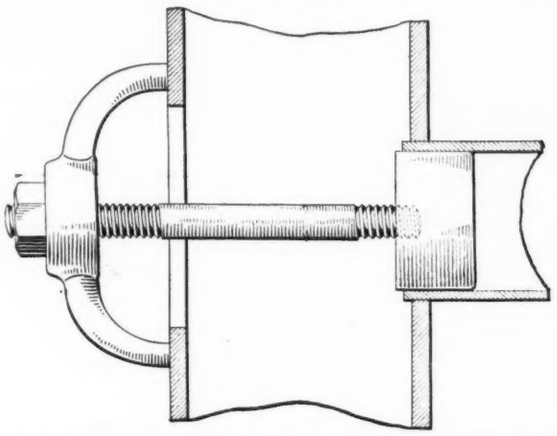


FIG. 1. PULLING WATER-TUBE BOILER TUBE PLUG

Each type of boiler can claim certain advantages. The water-tube is lighter and, because it can be forced much more, weighs considerably less per horsepower output than the Scotch. When a water tube lets go, the boiler must be taken off the line to plug the tube. With the Scotch boiler this may be done with little or no interruption, though it is a hot job—as hot as one ever is called upon to do in stationary work. Fig. 1 shows how the Babcock & Wilcox boiler-tube plug is extracted. The plug, stud and claw are furnished with the boiler. The plug is cast iron, fits the tube and is made tight by hitting it a few blows with a hammer. There are many ways of plugging the tubes of Scotch boilers, and these will be shown in an early issue. Fig. 2 shows an arrangement of B. & W. boilers common on lake steamers, many of which are now in the Atlantic service, although the more usual arrangement of boilers is with their axes fore and aft. Marine boilers are of two general classes, a small-tube and large-tube. The former have tubes from 1 to 2 in. diameter, while the latter's tubes are usually 3 and 4 in. and sometimes up to 5 in. diameter.

Water-tube boilers carry higher pressures and are faster steamers than the Scotch. Because of the divided water spaces in the water-tube boiler, it cannot be run with salt water as well as the Scotch. All modern ships have evaporators for the feed water anyway; but particular care should be used to keep the feed water free of salt for water-tube boilers. Usually the first or third assistant engineer takes the salinometer reading, it being entered in the log on many ships. How to operate evaporators, use the salinometer and test for chlorine are described in another article soon to appear.

The United States Shipping Board will provide some of the ships of its emergency fleet with a water-tube boiler which will, for all purposes concerning the engineer, be like a Heine boiler but having a cross-drum. As soon as the drawings are available, *Power* hopes to show a sectional elevation of this boiler. Other types of water-tube boilers that the engineer will find widely used aboard ship are the Yarrow, Thornycraft, Belleville, Seaton, Normand, White-Forster, Roberts, Almy and the Niclausse. The tubes of nearly all, if not all, these water-tube boilers may be removed by slitting the tube at each end with a chisel, hammering in the tube on each side of the slit, freeing the ends from the header or drum. The tube may then be pulled out.

The engineer is again urged to obtain a copy of the Rules of the Board of Supervising Inspectors of Steam Vessels and, if he can get them, the rules of the British Board of Trade. The requirements of some of the important rules of the former follow; but these are only a few of many with which the engineer should be acquainted. Address the Board, Department of Commerce, Washington, D. C.

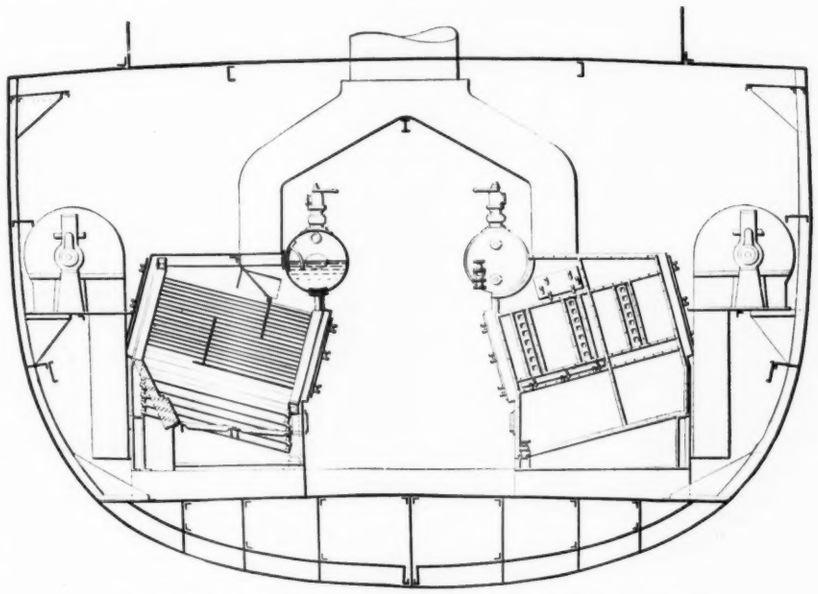


FIG. 2. ARRANGEMENT OF BABCOCK & WILCOX BOILERS ON LAKE STEAMER

Rule V, Section 33, states that it shall be the duty of an engineer when he assumes charge of the boilers and machinery of a steamer to examine them thoroughly and report anything found in bad condition to the master, owner or agent and to the local inspectors, who

shall thereupon investigate. If the former engineer has been culpably derelict of his duty, the inspectors must suspend or revoke his license.

Rule V, Section 34, makes it compulsory, before making any general repairs to a boiler, or when an accident or wear makes a boiler or other machinery unsafe, to report the same to the local inspectors.

Rule X, Section 4: Local inspectors, at their annual inspection of boilers may cause to be removed from the surface of the boilers such covering as may be necessary to remove to permit a thorough examination of the boiler.

Rule II, Section 7: The hydrostatic pressure for boilers "shall be in the proportion of 150 lb. per sq. in. to 100 lb. allowed on the boiler." That is, a boiler carrying 190 lb. would receive a hydrostatic test of

$$X : 190 = 150 : 100 = 285 \text{ lb.}$$

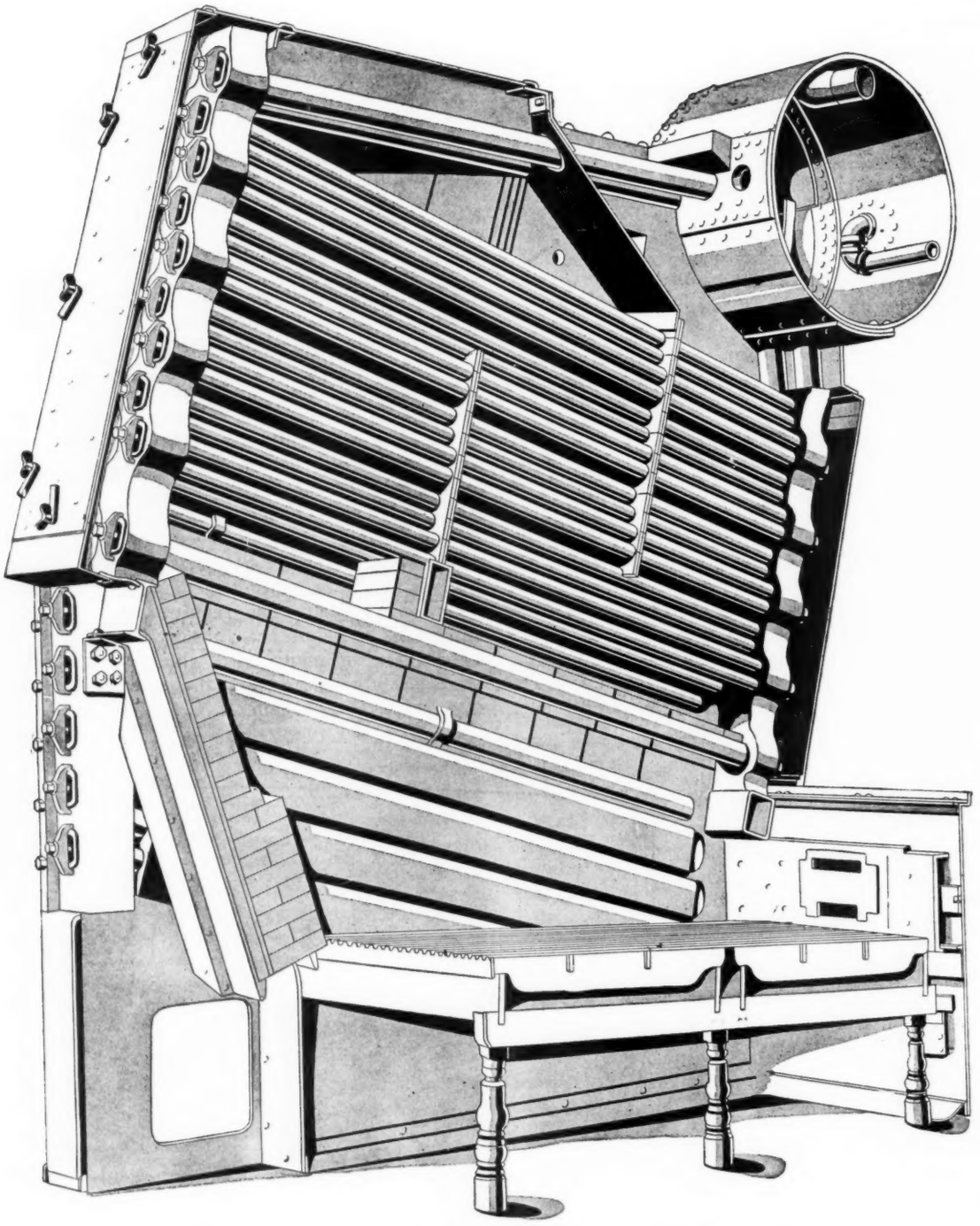


FIG. 3. MODEL SECTION OF BABCOCK & WILCOX MARINE BOILER

The local inspector must be present and observe the gage when the "official" hydrostatic test is made.

Rule X, Section 12: For carrying more steam pressure on a boiler than is allowed by the certificate of inspection, the engineer, master or owner is liable to arrest, and the United States district attorney must prosecute.

Editorials

The Corrosion of Condenser Tubes

THERE are some things that must be consumed in order to fulfill their useful purpose. Fuel must burn in order to generate heat, the seductive statements of the manufacturers of a new coal that it burns slower and produces more heat to the contrary notwithstanding. Ice must melt in order to absorb heat—or as a consequence of such absorption—notwithstanding the curious impression of some users that some kinds of ice cool off better and at the same time last longer than others.

A condenser tube does not need to waste away, however, in order to perform its function of separating steam and water while the heat flows through it from the one to the other. And yet they do, some of them, while others in the same service last for years and years unimpaired.

The man who would point out the reason why one set of tubes will last a dozen or twenty years while another set, of apparently the same chemical analysis and working under apparently the same conditions, will pit through in a few months would make the most important contribution to power-plant engineering since the invention of the steam turbine. The cost of retubing one of the enormous condensers which the turbine has brought into use is something tremendous, especially at the present prices of yellow metal, to say nothing of the loss of its service during frequent periods of repair. It looks like a simple problem, does it not? Here is one set of tubes that lasts, but all the resources of science are unable to determine why this one lasts and the other one does not; and all the resources of industry are unable to make another set that is sure to be equally immune from pitting. A committee of the Association of Edison Illuminating Companies, of which J. P. Sparrow, chief engineer of the New York Edison Company, was chairman, in a report submitted in 1913 said that the results of observations made upon tubes in service and of accelerated corrosion tests, led to the belief that the microstructure of the alloy had greater bearing on the corrosion and life of the tube than the actual composition of the alloy itself. A coarse-grained structure gave short life; a fine grain, if obtained by hard drawing, gave short life, but the fine grain of hard drawing relieved of strain by light annealing gave evidence of the longest life that could be expected from a particular alloy.

The latest utterance on the subject, that of William Ramsay, F. I. C., in London *Engineering*, is not encouraging. He says that the results of the work of the Corrosion Committee of the Institute of Metals are of academic interest rather than of practical engineering value. While throwing some light on the mechanics of brass corrosion in general, they only indicate, with a close agreement to practice, the order of durability of tubes made from the various alloys in general use. Mr. Ramsay says that assuming brass to be homogeneous, which it is not, it soon acquires a condition that renders it "auto corrosive," by which term he means that brass possesses within itself, or can acquire, the positive and negative elements necessary to form a galvanic couple which in sea water results in corrosion. He does not think different sea waters can have a varying influence on the rate of corrosion, but estuary waters containing sewage, sand, etc., certainly have such an effect. We know this, for stations on such waters as the East River at New York are continually replacing tubes, while other stations upon salt water get long life out of the tubes of the same composition. Tinning seems to add to the life of the tube in some cases, while in others it would almost have appeared to accelerate the breakdown. He thinks that careful and intelligent observation of actual cases of rapid local breakdown will lead to more useful information than laboratory experiments.

Another Coal Saver Discovered

YEARS ago a small boy in Ireland saw rank tea being thrown on the fire to make it burn more brightly and last longer. Today up in Toronto he is using tea to economize (?) the fuel burned in the plant of which he is the superintendent. He does not lay claim to having originated the idea, but when one of his staff suggested it as an experiment, he recalled what he had seen in Ireland and the plan was immediately put into practice. The results more than exceeded expectation. Tea that had been steeped for about two days was used with soft coal. After the fire had had a good start, the tea was poured over it. The fire burned brightly, but the coal was not consumed as rapidly as under ordinary circumstances. In fact, it was definitely proved that only two-thirds of the normal amount of fuel was burned up. At the most conservative figure, if the scheme were properly worked out, the experimenter believes that twenty-five per cent. of the coal we now use could be saved. The outlay is practically nil. Tea leaves are waste in any event. Why not turn them to account at a time when both tea and fuel are to be conserved as never before?

The main difficulty lies in securing enough tea to run large plants. The superintendent has a plan in mind which should prove feasible. He intends approaching some of the large restaurant managers and asking if an arrangement could not be made by which their

waste tea might be put at the disposal of the general public. It is inevitable that they waste a tremendous amount of tea, and they are not likely to be averse to turning this to account for the public weal at a time like this.

The explanation offered is that the tannin of the tea, owing to its astringent properties, "holds the gas until the fuel is consumed."

We do not doubt that the superintendent effected a considerable saving by this use of tea dregs. He could have gotten the same results with coffee grounds or, if his faith were strong enough, with plain water. Anything that will direct intelligent interested attention to the operation of the boiler will save twenty-five per cent. in many cases.

Electrical Recording Devices

THE operation of a power plant is similar to any other important business—it cannot be successfully carried on without keeping proper records. The larger the system the more necessary is a complete record at all times of what is going on in the plant and out on the distributing system. With simple two- and three-wire low-voltage systems, the value of records both as made by the station attendant and by recording instruments is largely a matter of efficiency and for the determination of the future requirements of the plant. The records from the instruments are also a check on how thoroughly the attendant performs his duties, such as putting machines into and taking them out of service at the proper time, maintaining constant voltage, seeing to it that the load is divided properly between the various elements, keeping records on the log sheet, etc. However, in high-voltage alternating-current systems the use of recording instruments is absolutely essential, in many cases, to the diagnosing of trouble that may occur on the system.

Probably no other recording device has had such an influence on the development of electrical apparatus as the oscillograph. It has been the one instrument that has shown what was really going on in the circuit or device under various conditions, such as the time a machine is started, the opening and closing of a circuit-breaker, transient conditions in induction machines, etc.—information that could not be obtained any other way. In fact, the oscillograph has been to the electrical industry what the indicator has been to the steam engine, but unfortunately it can be used only for special investigation, on account of the length of the record if used continuously. However, much that we know today about transient conditions in electrical apparatus and circuits would still remain a mystery if it had not been for this device.

In low-voltage circuits trouble is usually due to either open-circuits or short-circuits and lightning discharges when overhead lines are used. Short-circuits or grounds usually cause no more serious disturbance than the opening of a fuse or circuit-breaker, and if proper protection is provided, lightning seldom causes much trouble. In any case, whatever the cause may be, the trouble is easily accounted for, but in large alternating-current systems with a multiplicity of high-voltage circuits which are tied into one another in various ways, the cause of trouble becomes very complicated. It may be by the opening and closing of an oil switch, high frequencies, abnormal voltages, operation of a lightning arrester, short-circuits, arcing grounds, etc.

When trouble does occur, in many cases the origin is a mystery, especially if an attendant is relied upon to describe just what happened. At this period the need of immediate action on the part of the operator or other attendants usually makes it impossible to note the sequence of events, and the excitement renders their memory unreliable. Even if a trained observer happens to be at hand, the sequence of events during the trouble is usually so rapid as to prevent getting a correct record of them. Then again, many of the events are of such short duration that they cannot be observed. Consequently, in order to keep a check on all the events about the plant, not only in normal operation but in cases of trouble, it is necessary to use automatic recording instruments for voltage, current, output, frequency, etc.—multi-recorders that will indicate as high as fifty events at the same time; synchronoscopes that record the closing of the generator switches; and temperature-indicators that record the temperature in the various parts of the generator by means of temperature coils. This last device is a long step forward in preventing burnouts in the generators, since it is a well-known fact that temperatures observed in a machine may be far higher, under the same load, after it has been in operation for some time.

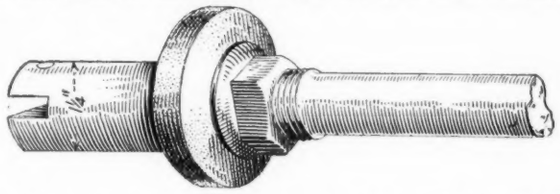
One occasionally reads of boilers that have been in use for twenty, twenty-five or even thirty years; but, as a rule, when a boiler has seen twenty-one years of almost continuous twenty-four-hour service, its period of usefulness is deemed nearly at an end. Not so, however, in the case of the boilers at the "Chain of Rocks" pumping station in St. Louis, where it was found profitable to rebuild the old boilers at a cost approximating one-half that of new ones; and with the addition of stokers, a new stack and breechings to effect economies in operation comparable with those of the most modern equipment. An unusual feature of the reconstructed boilers was the placing of the superheaters in the rear of the combustion chambers without objectional effects from the high temperatures encountered. The article in this issue is the first of three telling of the work of reconstruction and some of the problems encountered. These will be instructive to managements that are handicapped with out-of-date plants unable to meet present power demands and confronted with the present difficulties in procuring deliveries of new equipment.

The index to Vol. 45, the first half of 1917, is ready. All subscribers who have not already notified us of their desire to have an index should advise us so that they may have one mailed to them.

Correspondence

Pump Breakdown and Repair

In a plant where there are three compound, flywheel, Corliss-type elevator pumps, having two low- and one high-pressure cylinders, the piston rod of one of the low-pressure cylinders broke off at the last thread close to the crosshead nut. The cylinder and head were both cracked before the pump could be shut down, a crack extending across the head-end steam-valve chamber as far as the middle of the cylinder. When the cylinder was sent out to be oxyacetylene-welded, an attempt was made to run on two cylinders, but the receiver got too much steam, causing the relief valve to pop constantly; and as there was a duplex stand-by pump available, it was not thought necessary to go to the trouble of bleeding the receiver to the exhaust line, although this could have been done in an emergency. When the cylinder came back from the welders, the problem was how to smooth the valve chamber and remove the rough spots on the top of the cylinder, as none of the machine tools in the plant was large enough for the job. This was finally accomplished by using an emery wheel attached to a boiler tube-cleaner, as a grinder. A shaft carrying the emery wheel was attached to the tube cleaner and extended two feet beyond, so that a helper could guide and steady the grinder during the operation. The work was thoroughly done, and the valve apparently works as well as ever.



EMERY WHEEL ATTACHED TO ROTARY TUBE CLEANER

W. T. OSBORN.

Newark, N. J.

Navy Compound Satisfactory

We operated three single-drum B. & W. boilers for nine years without experiencing any trouble from corrosion or pitting, but soon after a new boiler was installed considerable pitting was noticed in all the drums and in some of the tubes. This was not confined to any particular part of the drums, but extended throughout all portions below the water line, at an alarming rate. Upon opening a boiler the scale formation was found to contain a large number of small blisters or ridge-like lumps, containing a black powdery substance over the pits in the boiler plate. These pits were deeper and larger at each inspection.

It had been the practice previously to operate two boilers at a time, running each for six weeks; thus cleaning periods occurred every three weeks. After cleaning, the boilers were filled and stood in readiness, and as cleaning took about a week, the time in which the boilers stood filled, but idle, was two weeks. With the new boiler the idle time was increased to five weeks, and as it was thought that this might be the cause of the trouble, one of the boilers was opened just before it was to be put into operation, and wherever pits occurred the drum was found covered with spots of red rust; this explained the blistered scale formation. So the practice of filling the boilers with cold water was discontinued, and hot water was used instead and the boiler was warmed up to the steaming point as soon as it was filled and warmed again in about three weeks. This gave little relief, and a boiler inspector after examining one of the drums advised using an internal boiler paint; a consulting engineer advised the use of Navy boiler compound. Several different compounds had previously been used with varying degrees of success, so it was decided to try the paint and Navy compound. A chemical analysis of the feed water showed the following impurities: Silica, 0.99; alum and iron oxides, 0.58; calcium carbonate, 3.66; calcium sulphate, 9.57; magnesium carbonate, 2.92; magnesium sulphate, 2.78; sodium chloride, 2.80; and water from the boilers before changing compounds gave an alkalinity of 2.8 per cent. with 85 gr. of chlorine per gallon. Enough Navy compound was used to hold the alkalinity at 3 per cent. (A detailed description of the necessary testing solutions and apparatus, as well as full instructions relating to tests and feeding of this compound, were given by Mr. Babcock on pages 910 to 913 of the issue of Dec. 28, 1915.) The boilers were all given a thorough cleaning and painted with an internal boiler paint and have since been in operation over a year, and the results, to say the least, have been favorable. Corrosion and pitting have ceased entirely; some scale forms in the tubes, making the use of a turbine cleaner necessary, but the scale that forms in the drums is thrown off in large sheets when the boilers are emptied, leaving the plates perfectly clean and the old pits showing no tendency to enlarge.

Sediment Not Serious

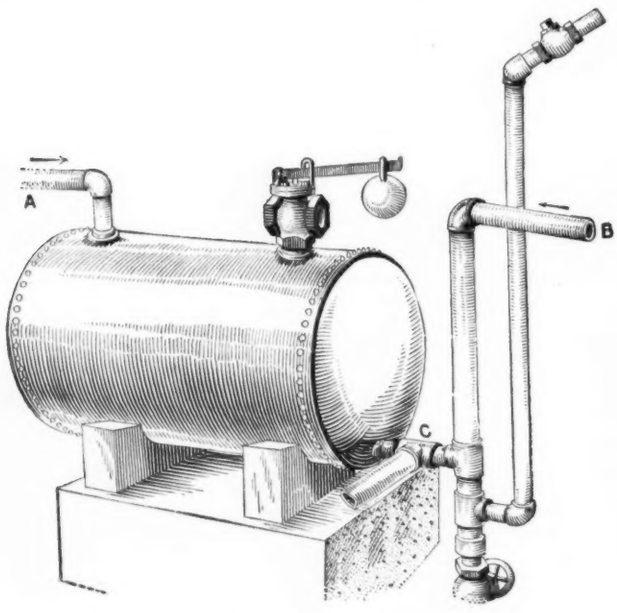
It has been noticed that a few days after the desired alkalinity has been established, the samples drawn off for test purposes contain considerable suspended matter—in fact, the water appears positively muddy—but in cooling, the suspended matter settles. This muddiness is also very noticeable in the water glass. The boilers are blown regularly each day, and as no ill effects have been experienced such as tube failures, etc., it is thought that as long as the alkalinity is kept at 3 per cent. the impurities held in suspension will do no harm. At one time a fresh supply of testing solution was delayed and the boilers were run for several days without tests and one of the boilers primed badly. It was found that the alkalinity had risen to 4.8 per cent.

The condensate from the heating system is used in the ice plant, and although the filter shows some signs of contamination, the ice is apparently free from compound. Another point in favor of the present treatment is its economy. The previous compounds used cost about twice as much per barrel and about twice the amount was used; this cuts the cost of compound to one-quarter. The chemicals and test apparatus cost about $25, and the renewal of used chemicals would amount to perhaps $15 a year and the internal boiler paint $1 per lb., and two coats of three pounds per coat have been sufficient. Thus the total cost for a year has been $60 for two barrels of compound, $40 for the test outfit and chemicals and $24 for paint—$124 in all; while four barrels of the compound formerly used at $60 cost $240. Thus a saving of $116 has been effected.

Del Monte, Calif. A. C. McHugh.

A Simple Vacuum Breaker

Water resulting from the condensation of steam at low pressure, used to heat one of the buildings in my plant, gravitates to a closed receiver from which it is returned to the boilers. Water enters at *A* and *B* and flows out through the side opening of *C* to the pump, but when steam is shut off from the heating system, or a change is made in operating that causes a reduction of pressure, a partial vacuum forms in the receiver and prevents water from flowing out at *C*, and the water remaining holds the float up and the throttle



SNIFTING VALVE ON RECEIVING TANK

valve to the pump wide open. This causes the pump to race violently before steam can be shut off, as the unit is in an out-of-the-way place. The following plan was adopted to prevent further danger. A vertical pipe was extended high enough to create a head of 6 ft. and the upper end was fitted with an ell, a short nipple, another ell and a swing check valve. The object of this is to permit setting the check at an angle that will allow the clapper to rest lightly on its seat, as it opens inwardly.

The operation is as follows: As soon as a partial vacuum is formed, it causes the check valve to open wide and air rushes in. This allows the pump to continue to work without change. Excessive air causes the pump to run rapidly with short strokes for a minute, but there is no danger of accident as the pistons are well cushioned, and the air does no harm in the system.

New Haven, Conn. W. H. Wakeman.

A Much-Abused Sawmill Boiler

At various times *Power* has had descriptions of remarkable old boilers and plants. The following may be of interest.

A crew was sent into the redwood belt of California one spring to prepare a sawmill for operation. Upon reaching the mill, situated in a deep canyon, the smokestack could be seen sticking out of a bank of mud. The creek had been dammed by a large slide during the winter, and when the slide washed out, the mud washed in and "camped" in the engine and boiler pit, which was located at one side and below the main deck of the mill. After a week of hard work most of the mud was shoveled out of the pit, but the front manhead of the boiler had been left off and the boiler was partly filled with clay. This was sluiced out with a hose.

The boiler was of the return-tubular type, about 125 hp., with a large horizontal steam drum, about a third as large as the boiler, connected to it by two short nipples. The date on the nameplate showed the boiler to be 35 years old, and "an old timer" in the woods said he "Allowed she was a durn good boiler, for three mills had burned down over her and she hadn't blowed up yet."

The steam drum and the part of the boiler above the furnace wall had never been lagged, and large flakes of rust as big as the palm of a hand could be scraped from nearly any part above the fire line. The engineer (?) after filling the boiler started a good fire to "see how she would steam," and steam she did; for at twenty or thirty places along the exposed longitudinal seam little jets of steam began to shoot out, some from under the rivet heads and others from under the lap of the joint. The safety valve leaked at 90 lb., so of course he applied "the remedy," added weight, some 50 lb. on the end of the already overloaded lever. But happily, he was even worse as a fireman than an engineer, and being unable to keep up steam, was replaced by another, who removed the extra safety-valve weight. "She hasn't blowed up yet," from all reports, and we hope she won't, until the new state boiler rules do the blowing right.

Del Monte, Calif, A. C. McHugh.

Some Pulp and Paper Mill Power Problems

The paper industry, like most others, has its peculiarities with regard to the power problem. Following is a short general description of how one mill, manufacturing soda pulp and magazine, book and writing paper, solves its problem.

Both pulp and paper mills are large consumers of steam per pound of output. At this mill there must be approximately twelve pounds of water evaporated in the

boilers for each pound of paper produced. In the soda mill steam is used to cook wood in the digesters, to evaporate large quantities of "spent" soda liquor, to heat water for washing pulp and for various other purposes; while in the paper mill it is used to heat pulp, to heat the driers of the paper machines, and in smaller quantities to heat water, etc.

Only the steam used in the digesters is taken directly from the boilers. It is reduced from boiler pressure (175 lb.) to 125 lb. gage, the limit of pressure allowed on the digesters. All the other steam used is called "low-pressure," 40 lb. gage. Single engines with piston valves are used to reduce the steam from boiler pressure to 40 lb.; that is, these engines take steam at boiler pressure and work against 40 lb. back pressure. The engines are direct connected to alternating-current generators to produce current for the motor equipment. The "low-pressure" steam is held constantly at 40 lb. by means of two automatic regulating valves—one to the atmosphere through a closed heater, and the other from the boiler header. This steam is then piped to all parts of the mill and made use of as described. With this arrangement the load on the boiler plant is quite constant for 24 hours a day and 6 days a week. The variation is not more than 10 per cent., hence the boilers can easily be run at an economical rating without forcing them at peak loads or banking fires at low loads.

Power-Using Machines in Paper Mill

Three-phase 25-cycle alternating current at 400 volts, driving induction motors, is used for power. The various types of machines to which the power is applied might be classified under the following heads: Fourdrinier paper machines, beating engines, jordan engines, supercalenders, agitators, centrifugal pumps, and miscellaneous drives. Each Fourdrinier paper machine is driven by two lineshafts, one variable-speed and one constant-speed. The variable-speed shaft is belt-driven from a 100-hp. engine and the constant-speed shaft is belt-driven from a 75-hp. motor. The beating engines require about 75 hp. each and are arranged in groups. Each group is belt-driven from a lineshaft to which a motor is direct-connected. Each jordan engine is direct-connected to a 150-hp. motor. The supercalenders require from 50 to 100 hp. and are driven by means of gears with cloth pinions on the motor shaft. The power required by the agitators depends entirely upon their size and speed, varying from 1 to 100 hp. These are all belted to the motors. The centrifugal pumps, of which there are a large number, are all direct-connected to motors, the most numerous being 15-hp. Miscellaneous motors include such drives as rewinders, cutters, stokers, rotaries, ventilating fans, shaker-screens and numerous other small drives.

In pulp and paper making large quantities of steam and water are used, and most places, especially the cellars, are full of steam and dripping water, so that extra precaution must be taken to protect the motors by means of covers. In the pulp mill the steam and water contain caustic soda, which is very destructive to insulation. The motors located therein must be entirely inclosed with sheet iron and must be ventilated by air piped in from the outside.

Beating engines, jordan engines and supercalenders quite frequently cause overloads on the motors driving them. As a precaution an ammeter is installed on each motor. All motors above 15 hp. are started with autostarters equipped with low-voltage release. The smaller motors and most of the 15-hp. size are started by "safety" oil switches equipped with low-voltage release.

A rigid system of inspection is maintained, day and night, which includes at regular intervals every motor in the mill. The policy here has been to avoid costly shutdowns by an inspection system which aims to detect signs of trouble and apply the remedy before it becomes serious.

R. G. Heyl.

Tyrone, Penn.

Vacuum in Engines and Turbines

In the June 26 issue, page 880, R. Manly Orr discusses the reasons why the steam turbine is able to utilize higher vacuum than the reciprocating engine. He mentions two—the limited size of the low-pressure cylinder of practical construction, and the limited velocity of exhaust steam. There is a third reason, more important and convincing than either of the foregoing: When live steam enters the cylinder of an engine, it meets with relatively cold metal walls and some of this steam is condensed. This initial condensation may be a considerable part of the total weight of steam admitted—as much as 40 or 50 per cent. at times. The water of condensation is deposited on the walls of the cylinder, which are exposed to the steam. The condensation of the steam involves a transfer of the heat of vaporization of the steam to the metal of the walls, thus warming the exposed surfaces. Presently the exhaust valve opens, and the warm, wet walls are exposed to the exhaust pressure. Immediately the water begins to evaporate. This process cools the cylinder walls. The degree of cooling depends, among other things, upon the pressure of the exhaust. If it is atmospheric, the walls will tend to cool down to 212 deg. If the pressure is only 2 lb. abs., the walls will tend to approach a temperature of about 126 deg. The lower the exhaust pressure the more rapid the cooling of the walls. This alternate heating and cooling of the cylinder surface, accompanied by condensation and reëvaporation of the steam, constitutes one of the most serious losses in the reciprocating engine.

As the exhaust pressure is lowered, the quantity of heat available for doing work is theoretically increased. But in the reciprocating engine the loss due to condensation increases at the same time. We might naturally expect that a point would be reached where the gain in available energy would be more than offset by the increased loss due to condensation. Such is the case. Experience indicates that the reciprocating engine gives its best economy when the back pressure is about 4 in. of mercury or, say, 26 in. vacuum.

In the turbine the steam flows through steadily. When in normal running condition the temperature of the metal at any point will be only a little below the temperature of the steam in contact with it. There is no alternate cooling and heating of any of the metal parts, and therefore there is no loss corresponding to the condensation loss of the reciprocating engine. When we lower the back pressure, we obtain the benefit of the

increase of available energy without increasing materially the losses incident to the operation of the machine.

Even if we could build cylinders large enough with ample exhaust ports and passages, the reciprocating engine would not benefit by high vacuum, but would show a poorer economy (that is, a higher steam consumption) than at the moderate vacuums usually employed in connection with such engines. The excellent economy of some of the recent designs of reciprocating engines, such as the uniflow and the locomobile, are due in great measure to the reduction of cylinder condensation.

C. H. BERRY,
Assistant Professor of Power Engineering,
Sibley College, Cornell University.
Ithaca, N. Y.

Higher Steam Pressures

P. A. Bancel's suggestion, in the July 10 issue, page 60, to increase the heat range of steam turbines by an extension of the vacuum rather than by an increase of the pressure and superheat—which had been the subject of previous discussion—calls for comment.

It should be remarked that the comparison which he draws, in proof of his thesis, between an expansion ranging from 600 lb. pressure and 700 deg. temperature to 28½ in. vacuum, and another from 350 lb. and 700 deg. to 29 in., is not exactly to the point. He wanted to illustrate "the gain from the use of higher vacua as against very high pressures and superheat," yet in both considered cases the pressures and temperatures are much beyond present-day practice, and the initial heat contents so nearly alike that the element of contrast is almost entirely lacking. These are not clean-cut, representative cases of such changes of state as the proposition seemed to offer for discussion.

The conclusions drawn from them can, therefore, not be very forcible. What is more, exception must be taken to some of the calculations by means of which Mr. Bancel proposes to demonstrate the superiority of the "high-vacuum cycle." I will recapitulate here, briefly, his deductions:

After having shown that the available energy is utilized with better efficiency at the lower end of the heat range, thereby compensating the slight advantage in heat drop which the 600 lb.-28½ in. expansion has over the 350 lb.-29 in. expansion, Mr. Bancel proceeds to take into account two important losses, which modify the comparison still more in favor of the high-vacuum cycle. These losses, which bear on the total thermal efficiency from boiler to condenser, are the heat wasted in the discharge circulating water and the heat wasted up the stack. The former, it is true, works somewhat in favor of the 28½-in. cycle, owing to the larger amount of heat retrieved in the condensate. But this advantage is largely overshadowed by the effect of the other source of heat loss; namely, that up the stack. The contention is made "that to produce the steam at 600 lb. pressure as against 350 lb., the boiler surface is 55 deg. hotter and therefore the uptake gases are 55 deg. hotter. With 14,000-B.t.u. coal and 80 per cent. boiler-plant efficiency, the ratio of steam to coal is 8.55, and with 20 lb. of gas per pound of coal, there are 23 lb. of flue gas per kilowatt [counting on 10 lb. steam per kw.-hr.]. The higher flue-gas temperature represents a heat loss of $23 \times 0.24 \times 55 = 304$ B.t.u."

This loss seems indeed to bring the balance overwhelmingly in favor of the lower-pressure-higher-vacuum cycle. But Mr. Bancel omits to mention that the value of 304 B.t.u., although quite correctly computed, relates to one kilowatt-hour, whereas the basis of all previous calculations is one pound of steam. Since 10 lb. of steam are consumed per kilowatt-hour, a reduction of 10:1 must, therefore, be applied, and there remain only $\frac{304}{10} = 30.4$ B.t.u., to be charged against the high-pressure cycle.

But even this reduced loss cannot be conceded; for the premise upon which it rests, that the uptake gases are 55 deg. hotter with 600-lb. steam than with 350-lb., would only be correct if saturated steam were produced. Since the steam is superheated in both cases to exactly the same temperature, or 700 deg. F., it is only fair to assume that the combustion gases leave the superheater (and enter the flue) at the same temperature in either case. It is therefore not justified to discriminate in favor of the lower pressure by neglecting to consider the steam temperatures.

It seems thus established that the conclusions that were arrived at by Mr. Bancel need some revising; in fact, for the particular case considered they must be reversed. This, nevertheless, does not affect the validity of his assertion that the increase of the vacuum offers a possibility of increasing the efficiency of a plant.

PHYSICAL POSSIBILITIES NOT ALWAYS DESIRABLE

Only, it should at the same time be emphasized that the limit for the vacuum cannot be extended at will and, furthermore, that the physically possible limits are not always desirable from an economical viewpoint.

The following table, borrowed from Moyer, "Steam Turbines," on the relation between steam pressures and circulating-water temperatures, illustrates the point.

VACUUM AT SEA LEVEL FOR VARYING TEMPERATURES OF COOLING WATER

Temperature of Cooling Water, Deg. F.	Theoretical Possible Vacuum, In.	Perfect Condenser No Temp. Difference, In.	Actual Condenser. 15 Deg. F. Difference, In.	Actual Condenser. 15 Deg. F. Difference, In.
Ratio Water to Steam	Infinite	60:1	60:1	100:1
32	29.83	29.67	29.43	29.54
60	29.50	29.12	28.56	28.82
70	29.30	28.77	27.72	28.38
75	29.10	28.51	27.37	28.11

In this table columns 4 and 5 are figured for a difference of 15 deg. between the temperature of the condensed steam and the discharged circulating water, which is about equivalent to 25 deg. between steam and incoming water.

This value has been reduced somewhat in modern practice, so that slightly better vacua than indicated may be obtainable.

On the other hand, all the vacua given are based on the steam pressures only, assuming no air to be present in the condenser. This obviously differs from actual conditions; as a matter of fact, even though providing air pumps displacing as high as 50 times the volume of the condensed steam, the air pressure in a commercial condenser is rarely figured to less than ¼ inch mercury. At best the vacuum is therefore limited, with very cold water, to about 29¼ in., while in summer time 28½ in. can hardly be exceeded.

The price, though, at which these vacua are obtained may be verified from the following table:

Vacuum	Volume of 1 Lb. of Dry Satur. Steam
26	176
28	342
29	665
29.4	1210

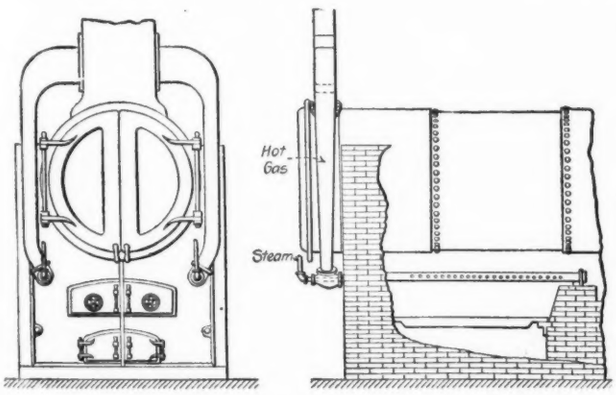
How the capacity of the condenser, the size of the sections of the last turbine stage and of the steam passages to the condenser will be affected by high vacua is here clearly visible, and it appears that, obviously, the production of a high vacuum is a matter of "cold cash" besides cold water. Indeed, the question of the "best" vacuum resolves itself, in every particular case, into a special economical problem and necessitates a close investigation of all the variables which affect its financial aspect. When the rate of decrease of the coal cost is equal to the rate of capital increase and other charges, the economical limit for the vacuum is reached. And it seems that present-day practice has almost gone, already, to that limit. PAUL HOFFMAN.

Easton, Penn.

A Smokeless Furnace

I have had a little experience along the line of the interesting article on page 64 in the issue of May 8, entitled "Combustion in Fuel Bed of Hand-Fired Furnaces." The smoke as a nuisance, in my case, was of no consequence, but the consumption of additional fuel was, hence the question was how to utilize the carbon passing through the flues and up the stack in the form of smoke.

My idea was that if I could draw the smoke from the stack or breeching back into the furnace, I could consume all the carbon and reduce the coal bill. So I cut



STEAM BLOWER AND HOT GAS CONNECTION

an opening in the breeching, ran a branch down to each side of the furnaces to a $\frac{1}{4}$ x 3 x 5-in. tee, as shown in the illustration, with a 3-in. extra-heavy perforated pipe extending the length of the furnace, with the holes facing inward and the ends of the pipes plugged. From the $\frac{1}{4}$-in. opening I extended past the 5-in. outlet, a long threaded pipe for steam, with the nozzle end reduced to $\frac{1}{16}$ in. in order to form a current from the breeching and force the smoke into the furnace through the perforated pipes. When, however, I started the device, I found the smoke was directly consumed in the furnace by reason of the hot gases being forced into the furnace, creating an intense white heat. This not only reduced the consumption of fuel, by consuming the smoke directly in the furnace, but it also facilitated the generation of steam by reason of no smoke passing through the flues, and increased the boiler capacity. The perforated pipes soon burned out, and I had them replaced by firebrick tuyeres set in the brickwork, with narrow longitudinal openings facing the furnace. The device was manipulated by the fireman admitting steam through the nozzle when fresh coal was put on and continued until the coal was coked, because to continue longer would only be a waste of steam. The device gave entire satisfaction. It can be installed by almost anyone, and the cost is practically nothing but the labor and pipe and fittings.

Philadelphia, Penn. WILLIAM S. LUCKENBACH.

Why Change the Clock?

Your editorial in the July 3 issue, "Why Change the Clock?" with its many good reasons therein given, is a splendid article, and I wish to compliment you on it and at the same time to add a few suggestions on this subject.

The proposed change of putting the clock one hour ahead, which Congress may put into effect next year, is an entirely unscientific method of trying to substitute law for common sense, and is an objectionable method of correcting mistakes of past generations. The attempt to correct our blind mental attitude by making the faithful clock lie to us is certainly extremely unscientific and ineffective. Owing to the almost universal provincialism of mankind, we allow our new ideas to be encumbered by our old ones, being literally tied to the past by our traditions, hence we drag them in and load them upon the backs of the new thought like the "Old Man of the Sea."

Our first clocks were made like sundials, our first railroad cars were like stagecoaches, our first automobiles were like buggies, and in each case there was a long interval of improvements and lost time in unloading the useless encumbrances.

The early savage believed that he stood in the center of the universe because the sky appeared to come down to the earth in equal distances from him on all sides, the sun, the moon and the stars were for his own personal needs, and when the sun was overhead it was his noon and hence noon to the whole world, his time being the only time. Fettered by that tradition, it is not strange that when in the course of civilization it became necessary to establish methods of reading time, each community established a time for itself without regard to the convenience of others. Then came the railroad, the telegraph, quick transportation and communication, which made local time obsolete and impossible. Then as a partial solution, Standard Time was introduced, and it proved to be better in the proportion that the total number of large cities and villages in the world bears to 24; or in other words, the vast number of local times were reduced to 24 zones as established by the Standard Time system. Yet it fell short of being perfect, because it divided the earth into 24 zones each 1000 miles wide instead of one zone 24,000 miles wide. The people on the border line of these zones are still subject to confusion, and a simple

statement of the hour has to be qualified by stating the zone also, such as Eastern Time, Central Time, Mountain Time, etc.

In the Standard Time we tried to retain an impossible noon hour, instead of disentangling it at once from the question of meal times and work hours and thus having an exact universal and scientific system and allowing the individual to determine his own time for work and refreshments.

If we could but lay aside our narrow-minded provincialism and in our mind's eye stand apart from the world and look at it as it really is—an insignificant ball in the great scheme of things—and assume that the earth is transparent, we would then realize that there is but one time on the earth at any instant. That is, from the beginning of the earth to the moment of the observation, there has elapsed a definite number of years, months, days, hours, minutes and seconds, hence if we assume at one place 10 o'clock, then at every spot on the earth's surface at that moment it will be 10 o'clock, an hour later it will be 11 o'clock, and so on.

Recommended by Washington Conference

The Washington Meridian conference in 1884 recommended a universal use of the 24-hour day (which has since been adopted by some countries), and if we add Universal Time to their recommendation, we would at once dispose of all the complicated questions of varying time.

It would not be necessary to select some point by agreement where the day starts, as is done at present, for the day would begin at 24 o'clock everywhere, and every clock keeping correct time would correspond with that time. If it were 8 o'clock in China, it would be 8'clock in Africa, Europe, America or elsewhere.

This would simplify railroad timetables and avoid many mistakes and errors incidental to the present system. Black and light letters on the railroad timetables could denote whether it was daylight or dark at any particular point.

As to the hours of labor, that would be a local matter, which it should be, and man could go to work at the time which was best suited to his local conditions. Today we are trying to crowd a thousand miles of the world's circumference into one time. With our present system, if work is started in both Buffalo, N. Y., and Omaha, Neb., at 8 o'clock in the morning Central Time, it is too early for the proper daylight schedule in Omaha and too late in Buffalo. By Universal Time they would start at the proper moment to conform to the best use of the daylight period each in his own locality.

At the conclusion of the present war there will be an adjustment of all our political, economic and social relations with all the world. Democracy will have planted its glorious banner on the ramparts of Universal Brotherhood. There will be a "getting together" such as the world has never known. Then we, who literally direct the wheels of progress, must come forward and institute reforms, tending to solidify and make permanent the great peace that will follow. The world will no longer be a heterogeneous, unwieldy mass of people. But with a universal impulse to better understand one another, there will be a demand for a standardizing of our inter-relations one with another. Then let us have universal time, universal weights, and measures and coinage and as a preventive of further misunderstanding let us have an artificial language on the order of "Esperanto," constructed on scientific lines, spelled as it is pronounced, pronounced as it is spelled, regular in all its verbs, tenses and declinations, and smooth and agreeable in sound. Such a language, owing to the fact that as it would belong to no nation, would be free from national prejudice and would be generally adopted. Each nation could teach this language coincidently with its own, and by the law of natural selection or path of least resistance this language would become world-wide in a comparatively short time.

If the new World Democracy could start with Universal Time, with its manifest advantage to transportation and trade; Universal Weights and Measures, thus unfettering commerce; Universal Coinage, eliminating the money changer, and a Universal Language to economize schooling and be the chief factor in preventing future wars—then should we have indeed approached near to Utopia, the land of greatest perfection in laws, politics and human endeavor.

Charles G. Armstrong,
New York City. Consulting Engineer.

Why the Pump Overstrokes

On page 881 in the issue of June 26 a question was asked regarding overstroking of one side of a duplex pump. The answer—that there should be less lost motion in the steam-valve gear on the side that overstrokes—is correct as far as adjustment goes, which no doubt was the whole intent of both the question and answer, but there are other possible causes requiring more heroic treatment. The cushion-release ports on this side may be larger than on the other side, permitting the piston to travel farther. The remedy in this case would be to reduce these ports by plugging them. The face of the valve or seat may be badly grooved or the valve improperly fitted and not closing tight, therefore not providing cushion for the piston. The steam valve should be refitted. The cushion may also be lost through a leaky steam piston or a scored cylinder. Refitting is the proper procedure.

My guess, however, would be that the difficulty was in the water end of the pump. Possibly there is considerable slip past the water piston and it should be repacked; or, what amounts to the same thing, the brass lining may be a poor fit to the cylinder and water may leak between the lining and the cylinder, permitting the piston on this side to travel more freely than the one on the other side The remedy in this case would be to make the brass lining tight in the cylinder by calking or by fitting a new lining. Possibly the suction valves on the offending side should be replaced, or the gasket between the discharge plate and the top of the cylinder may have cut through or blown out, permitting the water to pass from one end of the pulsation chamber to the other, requiring a new gasket.

The foregoing are the principal causes of overtravel, but there are other small variations which should be disclosed on making a thorough examination.

Holyoke, Mass. Robert E. Newcomb.

Inquiries of General Interest

Back Pitch of Rivets in Boiler Joint—What is meant by "back pitch" of rivets of a boiler joint? H. V. S.

The term "back pitch" is used to signify the distance between the center lines of any two adjacent rows of rivets measured at right angles to the direction of the joint.

Use of Two Motors on Same Countershaft—Where a countershaft is driven by a 100-hp. motor and it is desired to take about 150 hp. from the countershaft, can the load be driven by supplementing a 50-hp. motor? A. E. S.

It would be impracticable to drive with two motors, as the characteristics of the motors would need to be identical and remain so. One of the motors, attempting to run faster than the other, would take the whole load and drag the other along as a generator.

Safe Rim Speed for Ordinary Cast-Iron Flywheels—What is a safe rim speed for solid cast-iron flywheels of ordinary construction? P. J. K.

On account of difficulty in securing soundness of cast-iron flywheel rims, a tensile strength of 10,000 lb. per sq.in. is as much as can be assumed with safety. Using a factor of safety of 10 gives a maximum allowable stress of 1000 lb. per sq.in. of cross-section that corresponds to a rim velocity of 6085 ft. per min. The common rule of thumb for the safe rim speed of ordinary cast-iron flywheels is a mile (5280 ft.) a minute.

Putting New Anchor Bolts in Old Foundation—What method can be employed for putting in and securing foundation bolts for a new engine on an old foundation of concrete requiring new locations of bolts? P. D. F.

Drill bolt holes in proper locations and insert new bolts with reduced split ends expanded in the bottoms of the holes by driving the bolts against steel wedges. If the bolts have been roughened as by cutting rasp-like teeth along their length and are thoroughly grouted in place with neat cement, they may be securely anchored.

Efficiency Required on Longitudinal Joint—What per cent. of efficiency would be required of the longitudinal joint of a cylindrical boiler shell 72 in. diameter and made of $\frac{7}{16}$-in. steel of 55,000 lb. tensile sertngth, for a working pressure of 150 lb. per sq.in. with a factor of safety of 5? F. C.

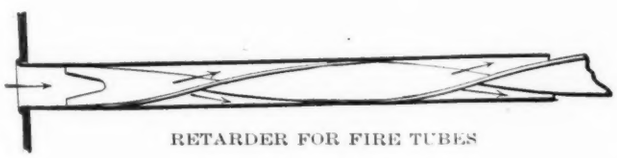
Calling the required efficiency E, then by reduction of the equation,

$$\textit{Working pressure, 150 lb. per sq.in.} = \frac{55{,}000 \times \frac{7}{16}}{36 \times 5} \times E,$$

the value required for E is found to be 0.8728, or practically 87¼ per cent.

Retarders for Flues of Fire-Tube Boilers—What are "retarders," which are said to be used for improving the efficiency of boilers? L. B.

The name is given to long twisted strips of thin steel, as shown in the sketch, which are laid in the fire tubes of horizontal boilers to give the gases a rotary motion for throwing them out against the tube surface and thus bring every portion of the gas into contact with the tube. Retarders have been used with an increase of economy when employed in boilers supplied with forced draft and high rates of combustion.



RETARDER FOR FIRE TUBES

Scale Deposited Inside of Fire Tubes—What would cause an accumulation of a lime-like scale on the fire side of the tubes of a horizontal return-tubular boiler? Might such a deposit arise from use of a steam tube cleaner? R. G. S.

The presence of scale inside of the tubes would indicate a deposit out of the boiler water containing the incrusting material. A very small leak at the tube sheets or through pin holes in the tubes may be responsible for the deposit, or if wet steam is used for operation of the tube cleaner the scale material may be deposited out of the water entrained in the steam.

Vents on Blowoff Tanks—Is it customary to have the blowoff tanks of boilers vented, and what damage could be done in blowing down a boiler if no vent pipe is provided? P. M.

It is customary in good practice to provide liberal-sized vent pipes, to relieve the tanks of pressure when receiving blowoff water or steam from the boilers while under pressure and for admission of air to the tanks when they are being emptied. Other methods of venting such as by manholes and other openings are objectionable for blowoff tanks, placed within buildings, from the danger and nuisance of escaping steam and splashing of hot water in the vicinity of the tank whenever the boilers are blown down. Unless a vent pipe or some means is employed for relieving the tank of pressure while receiving the blowdown from a boiler, a pressure at least equal to that of the boiler pressure is quickly accumulated in the tank, endangering it to bursting.

Air Required for Burning 100 Lb. of Coal—Assuming that $1\frac{3}{4}$ times the theoretical quantity of air required for combustion is supplied, how many cubic feet of air would be required to burn 100 lb. of coal consisting of hydrogen 6 per cent., carbon 88 per cent., oxygen 3 per cent. and ash 3 per cent? J. J. K.

The atomic weights of hydrogen, carbon and oxygen are, H = 1, C = 12 and O = 16. In combustion of coal the H is converted to H_2O; that is, 2 lb. of hydrogen will combine in forming water with 16 lb. of oxygen of the air supplied, or 1 lb. of H combines with 8 lb. of O. If the carbon is completely burned the product will be CO_2 and since the atomic weight of C is 12, the proportion of oxygen to carbon will be (2 × 16) to 12, or $2\frac{2}{3}$ lb. O to 1 lb. C.

It may be considered that all the oxygen that is in the coal is already combined with a part of the hydrogen and is inert as far as combustion is concerned, and the 0.03 lb. of oxygen in each pound of the coal will be already combined with 0.03 ÷ 8 = 0.00375 lb. of hydrogen, so that the air supply per pound of the fuel will need to be sufficient to furnish (0.06 — 0.0035) lb. of hydrogen × 8 = 0.45 lb. of oxygen, and 0.88 lb. of carbon × $2\frac{2}{3}$ = 2.346 lb. of oxygen, or a total of 2.796 lb. of oxygen per pound of the coal.

As air contains about 0.23 parts by weight of oxygen, the amount of air that would contain 2.796 lb. of oxygen would be 2.796 ÷ 0.23 = 12.15 lb., and this would be the theoretical weight of air required to supply sufficient oxygen to completely burn 1 lb. of the coal. One pound of air (at 62 deg. F.) has a volume of 13.14 cu.ft., and therefore $1\frac{3}{4}$ times the theoretical quantity of air required for combustion of 100 lb. of the coal would be

$$12.15 \times 13.14 \times 1\tfrac{3}{4} \times 100 = 26{,}608 \text{ cu.ft. of air.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

General Conditions in Electrical Industry*

ESTIMATED figures of the electrical industries prepared in the latter half of 1916, based generally on the returns made to the U. S. Bureau of Census, show a total investment of $12,129,660,000, employees to the number of 1,023,000 and annual earnings on sales of $2,324,700,000. This tremendous total is probably more nearly correct than some of the individual items. Moreover, it is not by any means to be attributed to the war boom, the real extent of which no one can yet measure. For example, in electrical manufacturing, the output amounted to over $500,000,000, with orders in hand for 1917 in execess of $200,000,000, a total of over $1,000,000,000 might have been reached could all the domestic trade have been supplied as well as the foreign trade open to excess.

Part of this huge value would be chargeable to higher cost of raw materials and higher labor costs; but while electrical exports climbed to $40,000,000, it is obvious that a very small proportion of the market was accessible. In 1914 the total production of specific electrical goods was $369,000,000; last year three firms made sales of $305,000,000, with excess orders of more than $100,000,000.

In the meantime the central-station industry has been undeniably prosperous. The conditions are very comprehensively shown in the fact that the load had so thoroughly overtaken capacity in 1916, and was still advancing at such a rapid rate, that it became necessary for stations to place orders for not less than 2,000,000 kw. in steam turbines and about 400,000 kw. in water turbines. It seems quite safe to assume that the industry earned about $425,000,000 for service, but as some 2500 stations are also engaged in the supply business, in steam heating, ice-making, etc., it may well be that the total income was in excess of $450,000,000. Such an estimate is a striking one, but the fact remains that the amount might have been higher if the plants had been in existence to take on the new loads offered.

Industry Increases in 1916 Over 1915

These gross earnings were higher than those of 1915 by over 15 per cent., and the output went beyond that rate, the rate for the year being estimated at 23 per cent. There is some evidence here of rate reduction, lowering the income and increasing the volume of business; but it must of course be remembered that the sale of electric service in large bulk quantities is now getting into its real stride. The 1916 earnings were larger than those of 1915 by more than $50,000,000, and the increase in output would appear to have been 4,265,000,000 kw.-hr., or up to a total of 23,000,000,000 kw.-hr. The influence of bulk sales of energy is thus shown in an apparent return over the whole field of less than 2c. per kw.-hr. It may be noted as an example of the heights that can be reached by a large system in these days, that on Dec. 19, 1916, the Commonwealth Edison Co. delivered to its Chicago distribution system 5,176,527 kw.-hr., on which day the peak load, the company's highest record was 369,740 kilowatts.

After commenting on the increased cost of materials and the labor situation, the report continues: The other serious item entering into the higher cost of energy production has been the spectacular increase in the price of coal coupled with the difficulty of getting it. For this state of affairs, due it is plain to various reasons, such as decreased output, increased industrial demand, fewer cars available, congestion on the railroad tracks, greed of coal-selling and coal-handling firms, no real remedy has been found, and it is feared that the higher prices may persist.

Our own necessities also penalize us. The Chicago system is using 7000 tons of coal per day, and its consumption doubles every four years, so that by 1929, should present conditions persist, it would be no less than 66,000 tons per day. Such figures are alarming, and certainly should invite intense study on the part of the railroads. For ourselves there are lessons and suggestions. If Chicago, in 1929, is quite likely to use over 20,000,000 tons of coal for its central-station system, it means a cost of fuel at, say, $1.50 per ton or over $30,000,000. The entire cost of all fuel for the whole industry in 1912, with 5221 stations was slightly less than $35,000,000. The estimated price of $1.50 will be absurdly low to many of our member companies in view of the experiences of the past winter. However, it is desired not to be unduly pessimistic in regard to a situation of unusual complexity, but simply to emphasize the thought of "preparedness."

Rates can no longer go down when such conditions confront the industry. To advance them will be difficult though necessary, possibly adjusted to a sliding scale of cost of energy production. Meantime there is a consolation and compensation in the fact that the individual power producer has felt all these adverse conditions in even intensified form, and has been only too glad to drop all his troubles by hooking up with central-station circuits. The enormous extent to which this has been done is not yet realized, but the lesson as to increasing facilities is as important for us as it is for the railroad in handling the traffic of the near future

Pounds of Coal per Horsepower-Hour

The report of the British Royal Commission on Coal Supplies in 1905, gave an average figure of 5 lb. of coal per horsepower-hour as being the consumption by industrial concerns in the production of their own power, whereas, in modern central stations this could be reduced at least one-half. The inference is irresistible from that basis, leaving out many other arguments and considerations as to the manner in which the tendencies of the times must shape themselves.

It is, however, quite difficult to estimate to what extent the industry had covered its field of activity in 1916, with so many new departments of energy supply opening up, especially in electrochemistry and electrometallurgy. There were about 6,000,000 meter customers in the United States, which would indicate that at least 1,500,000 factories are taking service. There were about 5,500,000 houses lighted by electricity, but as statistics would show about 20,500,000 homes in the country, this would apparently leave 15,000,000 unwired, of which perhaps one-half may be within reach of present or prospective central-station circuits—just how many no one can tell with any kind of definiteness or exactitude.

Electricity in the Copper Industry

As one illustration of the effect of electrifying an industry by modern central-station methods, reference may be made to the Anaconda copper mine, which is producing at the rate of 330,000,000 lb. annually and is using electric energy to the amount of 700,000,000 kw.-hr. per year, or at the rate of about 2 kw.-hr. per pound of copper produced. Applied to all the power needed for mining reduction and transportation operations, electrification has meant a saving to the Anaconda of about $3,500,000 to $4,000,000 annually as against what could be done with steam power under present conditions and the present rate of operation, and much more as against what was done with the isolated plants in use before electricity was substituted. Applied to the present rate of production this means a saving of more than 1c. per pound.

As evidence of urban supply growth, though the figures are slightly belated, it may be noted that the total energy output of the electric companies operating in New York City, sold to the public during 1915, according to the report of the Public Service Commission, First District of New York, was 727,004,884 kw.-hr., an increase of 7.73 per cent. over the preceding year. The number of customers was 306,217, as against 265,254 in 1914. The total revenue from sales of energy to the public was $344,936,019. This is the first time since the commission was created that the annual revenue for the sale of electric current has exceeded that from the sale of gas.

*Abstract from the 1917 Report of Committee on Progress, of the National Electric Light Association.

Tar Oil as Diesel Engine Fuel*

By GEOFFREY PORTER

THE use of tar oil produces greater temperatures than does the use of a residual-petroleum fuel, but the increase is not of high value when allowance has been made for the slower-burning property of tar oil by advancing the fuel admission. In the engine fitted with pilot-jet of residual-petroleum ignition gear, under my own charge, sudden pressure increases occur occasionally at starting. I believe that all of us who have used tar oil, with or without pilot-jet ignition gear, have found it necessary to advance the fuel admission, the setting for residual petroleum oil being generally too late for the slower burning tar oil. In general, a card taken from an engine using tar oil with pilot-jet ignition is not so nicely shaped as a card taken with residual petroleum alone or with tar oil alone as fuel. The prior ignition of the pilot jet produces a "peaked" admission line in comparison with the regular, slightly drooping curve, which denotes combustion at constant pressure.

My own experience has been with an engine equipped with Messrs. Mirrlees, Bickerton & Day's pilot-jet ignition gear, and most of my remarks will refer to this engine. The tar-oil supply is delivered by the main fuel pump to the cylinders under the control of the governor. The ignition oil is independently supplied, but is not under control of the governor. The quantity of ignition oil is a fixed amount at all engine loads. The ideal quantity is 5 per cent. at full load. The quantity of oil delivered by the ignition pump is set by an arrangement that permits the same adjustment to be given to each pump, each cylinder having its own ignition pump. Since the ignition pump is not controlled by the governor, it is advisable to set the governor to keep the engine speed, if anything, on the low side, as the engine may "run away" when the load is thrown off suddenly. The smaller the quantity of ignition oil used, the less probable is this condition. The provision of some electrically controlled safeguard in connection with the ignition-oil supply would be a desirable feature to adopt. In starting, the engine invariably runs about 20 or 30 revolutions above normal speed. I have run the engine on 4 per cent. of normal full load on the fuel supplied by the ignition pumps alone when set to deliver their maximum quantity.

Speed Control by Governor Satisfactory

In the ordinary course of running the engine (driving a direct-coupled dynamo) I find the speed control by the governor to be as satisfactory when using tar oil as when burning residual petroleum oil. Impulses are regular, it is seldom that a cylinder "misses," and one would not be aware that a change of fuel had been made. The engine runs well even on 1/30 load.

Before beginning the use of tar oil, one or two adjustments must be made. An earlier fuel admission is necessary, owing to the slower-burning properties of the tar oil as compared with residual petroleum oil. In my own experience I find an advance of about 1 deg. on the crank circle suffices. Similarly, the closing of the needle valve needs a rather earlier adjustment. The only definite method to adopt is that of trial and error. As with residual petroleum oil, the condition of the color of the exhaust is a guide to correct timing. I have had no difficulty in obtaining colorless exhaust at all loads with injection pressures of the same magnitude for tar oil as for residual petroleum oil. When attempting to use tar oil without ignition gear, I found it necessary to reduce the injection pressure to a large extent in order to obtain satisfactory operation. Engineers who use tar oil as the sole fuel have also found the reduction of the injection pressure essential for steady operation.

Another important point to consider is the compression pressure in the cylinders at no load. This pressure should not be less than 480 lb. per sq.in. Below this figure both the ignition of the tar oil and of the residual petroleum oil may be uncertain; and even if regular ignition is obtained, combustion may be incomplete, leading to smoke and high exhaust temperatures. The engine in which I am interested had been at work for a period of 14,000 running hours before being adapted to tar-oil fuel. Nevertheless, the engine has done good service, using tar oil for the last nine months, being at work at 65 per cent. of full load (average) for 16½ hours per day. Mr. Prentice has also obtained very consistent working with the engine he is operating with tar oil without a pilot jet. He informs me that the engine has been operated for 2250 working hours at ⅞ of full load during nine months, or about eight and one-quarter hours per day.

Cylinders Require Relief Valves

I think it very desirable to fit relief valves to the cylinders when using tar oil. Increases of pressure do occasionally occur at starting, and it is essential, in my opinion, to take all reasonable steps to avoid adding to the already high stresses in the engine parts. The relief valves are set to lift at 750 lb. per sq.in. In the event of a number of "misses" causing an accumulation of fuel on the piston head, and this accumulation suddenly firing, very considerable excess pressures may arise. It is improbable that any relief valve will prevent an explosion, but it will give useful warnings and will take care of all minor pressure troubles.

The pistons get very dirty, causing the rings to become fast in their grooves, and should be examined at three months' intervals. The exhaust valves give no trouble. They are cleaned and ground in at intervals of 250 running hours. The original exhaust valves supplied with the engines 5½ years ago are still in use. The fuel pumps are rather more troublesome than formerly, owing to the greater amount of sludge found in them. The lower viscosity of the tar oil also renders it more difficult to maintain the plunger glands tight than was the case when using residual petroleum oil.

Pulverizers Give Trouble Owing to Choking of Cone Grooves and Rings

In the pulverizers we have endless trouble owing to the choking of the cone grooves and rings. Frequently also the passages in the fuel-valve casing become choked. The deposit collects rapidly; under the conditions I am familiar with, the deposit must be removed after 50 to 60 hours' running at about 65 per cent. of full load. If the fraction of full load is greater, the deposit forms more rapidly. This difficulty is very generally found by engineers using tar oil. All tar oils do not show it, and others do so in varying degrees. On some days the deposit is very slight, at other times very heavy; sometimes exceedingly hard, and again very soft. Engineers have told me that their pulverizers have choked in 12 hours or less. In some instances the deposit is normally so great that it is necessary to reduce the full-load rating of the engine. In my own case the deposit has been less since the warm summer weather set in, and this inclines me to suppose some connection between the crystallization of the oil in the storage tanks and the deposit in the pulverizers. The cause of the deposit is still obscure. Several engineers have completely got rid of deposits by adopting another pattern of pulverizer. A type which secures the pulverizing of a film of oil appears to be satisfactory.

Another small point from personal observation is the improved running obtained by increasing the injection pressure at all loads by about 20 lb. per sq.in. The "cadence" of the engine and the operation of the top gear are then very much more regular. No doubt pulverization is improved, the impulses are more even, and the governor runs more steadily.

The figures given in the two tables relate to a pair of exactly similar engines, one burning residual petroleum, the other tar oil with a pilot-ignition jet. Higher efficiencies are obtained with the oil of the lower calorific value. I assume the result has its origin in the fact that the residual petro-

*Abstract from a paper presented at a recent meeting of the Diesel Engine Users' Association, England.

leum we are now obtaining has a lower heating value than the oil obtained before the war broke out.

FUEL OIL—RESIDUAL PETROLEUM

No.	Load Factor, per Cent.	B.T.U. per Kw.-Hr	Over-all Thermal Efficiency	Cost of Fuel, Pence per Kw.-Hr.
1	32.1	15,650	21.7	0.931d. (1.86c.)
2	47.1	15,480	21.8	0.981d. (1.96c.)
3	61.2	13,370	24.1	0.836d. (1.67c.)
FUEL OIL—TAR OIL WITH PILOT-JET IGNITION AT FULL LOAD				10.3 PER CENT.
1	36.3	15,005	22.6	0.458d. (0.916c.)
2	47.2	13,229	25.79	0.399d. (0.798c.)
3	49.5	15,205	24.23	0.410d. (0.820c.)
4	62.4	12,615	28.9	0.399d. (0.798c.)

These figures are not results of trials, but are taken from the daily records, and are put forward as an example to indicate approximately the limits within which results may be expected to lie.

Plastic Cements*

By J. B. Barnitt

One of the principal precautions to be observed in the application of a cement is the condition of the material to be joined. All connections should be properly fitted together with flanges or exposed flat surfaces as nearly coincident as possible. The cement should never be depended upon to do what the pipes or other portions of the apparatus should do. Its function is to cement or seal and nothing more. In most cases one part of the fitting should overlap the other so as to make a small amount of the cement effective. Cement for a joint of this type should be of a nature that may be quickly applied, that is effective while in place and easily removed when desired. An excess of cement should always be avoided to prevent shrinkage, cracks and leaks. The general methods of plastic cement application are varied to suit special cases as follows:

a. Heating the composition to make it plastic until firmly fixed in place.

b. Heat applied to the surface to be cemented.

c. Application of the cement with water or a volatile solvent, depending upon the evaporation of the solvent for drying or setting.

d. Moistening the surfaces to be cemented with water, oil, etc. (The vehicle of the cement itself.)

e. Application of the cement in workable condition, setting taking place by (1) chemical reaction, (2) hydration, (3) oxidation.

The application of the following materials as plastic cements is noted: (1) Plaster of paris; (2) hydraulic cement; (3) clay; (4) lime; (5) asphalt or pitch; (6) resin; (7) rubber; (8) linseed oil; (9) casein and albumen; (10) silicate of soda and oxychloride cement; (11) flour and starch; (12) miscellaneous materials.

Plaster of Paris—Plaster of paris is often used alone as a paste for joints on gas and wood distillation retorts and similar places where rapidity of setting is a requisite. In order to impart strength, a fibrous material such as asbestos is often mixed with it. Shavings, straw, hair and cloth are frequently used as binders, when a high temperature is not required, while stone, glass and various mineral substances are used as fillers. The following cements are particularly suitable for oil vapors and hydrocarbon gases:

a. Plaster and water.

b. Wet plaster and asbestos.

c. Wet plaster and straw.

d. Wet plaster and plush trimmings.

e. Wet plaster and hair.

f. Wet plaster and broken stone.

Hydraulic Cement—Cement is used either alone or with sand, asbestos, etc., and is especially resistant to nitric acid. When used with resin or sulphur it is employed as a filler rather than for any powers of setting by hydration:

Clay—This frequently enters into the composition of plastic cement as a filler. The finely divided condition of the material gives body to a liquid such as linseed oil, which, unless stiffened, would be pervious to a gas, the clay being inert:

a. Clay and linseed oil is suitable for steam.

b. Clay, linseed oil, and fireclay for chlorine gas.

c. Clay and molasses for oil vapors.

Lime—Caustic-lime and linseed-oil mixtures are used as a putty. Chalk or china clay frequently replaces part of the lime, but enough lime should remain to maintain the caustic property necessary to the formation of a certain amount of lime soap.

Asphalt and Pitch—Asphalt and pitch are used interchangeably in plastic cements, pitch making the stronger binder. Tar is of less value on account of the light oils and water contained in it. For waterproofing, melted asphalt with a small amount of paraffin added, and in particular cases boiled oil, is used:

Pitch, 8 parts; resin, 6 parts; wax, 1 part; plaster, ¼ to ½ part; or pitch, 8 parts; resin, 7 parts; sulphur, 2 parts; stone-powder, 1 part; are used to unite slate slabs and stoneware for engineering and chemical purposes. If acid vapors or corrosives gases come in contact with the cement, limestone should not be the powder used, otherwise it is best. Wax prevents the composition from becoming brittle.

Plastic cements for calking must be both tough and elastic, and have the added property of expanding and contracting with the joint to which they are applied:

Resin, Shellac and Wax—A strong stone cement having little body and applied in layers.

a. Resin, 8 parts; wax, 1 part; turpentine, 1 part. For nitric- and hydrochloric-acid vapors.

b. Resin, 1 part; sulphur, 1 part; fireclay, 2 parts. Sulphur gives great hardness and permanency in resin cements.

Good waterproofing cements are:

c. Resin, 1 part; wax, 1 part; powdered stone, 2 parts.

d. Shellac, 5 parts; wax, 1 part; turpentine, 1 part; chalk, 8 to 10 parts.

For a soft air-tight paste for ground-glass surfaces:

e. Wax, 1 part; vaseline, 1 part.

A strong cement without body for metals (not copper), porcelain, and glass.

f. Powdered shellac, 1 part; ammonia water, 10 parts. Allow to stand until solution is effected.

Rubber—Because of its toughness, elasticity and resistance to alterative influences, rubber is a very useful cement.

As a leather cement:

a. Asphalt, 1 part; resin, 1 part; gutta percha, 4 parts; carbon disulphide, 20 parts.

As a resistant to acid vapors:

b. Rubber, 1 part; linseed oil, 2 parts; fireclay, 3 parts.

A plain rubber cement:

c. Cut crude rubber in small pieces and then add carbon disulphide or benzol, allowing the rubber to dissolve.

Corks and wood are made impervious to water by soaking them in the above solution.

Linseed Oil—Linseed oil is one of the most generally useful materials for cementing purposes.

For aqueous vapors:

a China clay and linseed oil.

b. Lime and linseed oil, forming the well-known putty.

c. Red or white lead and linseed oil.

The foregoing mixtures become very strong when set, and are best diluted with powdered glass, clay or graphite.

d. Oxide of iron and linseed oil.

Casein, Albumen and Glue—Cements of this nature, if properly made, become very tough and tenacious, are resistant to moderate heat and oil vapors but not to acid fumes.

a. Finely powdered casein, 12 parts; fresh slaked lime, 50 parts; fine sand, 50 parts; and enough water to make a thick mass.

A strong cement for ground unions standing a moderate heat.

b. Casein in fine powder, 1 part; rubbed with silicate of soda, 3 parts.

c. White of egg made into a paste with slaked lime. This should be used immediately after being made up.

A composition for soaking corks, wood packing, etc., to render impervious to oil vapors:

*From "General Chemical Bulletin," Laurel Hill Laboratory, February, 1917, and reprinted in "Mechanical Engineer," Manchester.

d. Gelatin, 2 parts; glycerin, 1 part; water, 6 parts.

Silicate and Oxychloride Cements—For oil vapors standing highest heat:

a. Paste of sodium silicate and asbestos.

For gaskets for superheated steam retorts, furnaces, etc.:

b. Sodium silicate and glass.

c. Sodium silicate, 50 parts; asbestos, 15 parts; slaked lime, 10 parts.

A metal cement:

d. Sodium silicate, 1 part; oxides of zinc, lead or iron, singly or mixed, 1 part.

e. Zinc oxide, 2 parts; zinc chloride, 1 part; water to make a paste.

f. Magnesium oxide, 2 parts; magnesium chloride, 1 part; water to make a paste.

Flour and Starch—a. Flaxseed makes a very tough cement, but does not withstand water.

b. Flour and molasses to a stiff paste.

A permanent cement for ordinary temperatures impervious but attacked by condensing steam and nitric vapors.

c. Stiff flour paste and concentrated zinc-chloride solution.

Miscellaneous—For insertion of glass tubes in brass or iron:

a. Litharge and glycerin mixed to a stiff paste.

For high heat:

b. Alumina, 1 part; sand, 4 parts; slaked lime, 1 part; borax, ½ part; water.

Safe Boiler-Room Practice

The following safe practices have been widely quoted as being equal or superior to any similar specifications:

Safe practices mean thinking safety.

Safe practices mean practicing safety.

Safe practices mean an orderly workroom.

If a leak is detected, notify the management.

An improperly operated boiler is as dangerous as dynamite.

A careful fireman + a clean boiler room = safe operation.

Blowoff and all other valves should be opened and closed slowly.

Continual watchfulness and care are required of every fireman.

Do not allow obstructions of any nature on ladders, stairways or runways.

Keep the water level constant by feeding water in small quantities.

Careless habits should be noted and the workman warned as to dangerous practices.

The safety valve is your life preserver. Test it every day to see that it is working properly.

Keep your hand on the stair-rail. In boiler rooms the stairs are often steep and are sometimes narrow and difficult.

Clean water glasses and pressure gages are necessary.

Know the working pressure allowed for each boiler by the inspection certificate. Never exceed this pressure.

At the beginning of each turn, test the safety valves and water gages and see that the water is at the proper level.

Owing to the danger of the accumulation of gases in basements or subways to boiler rooms, good ventilation should be provided. It is the duty of the foreman to see that these places are safe.

Cleaners and repairmen should be provided with padlocks and "danger" tags, with positive instructions for their use when entering dangerous places.

Firemen should be encouraged to wear shoes that will properly protect their feet. In many locations the shoes such as are worn by molders could be used to advantage.

Face the ladder in ascending or descending. Don't slide down.

Racks and hooks and nails driven into the walls of passageways are a common hazard.

The wearing of hand leathers is always advisable and often necessary in many of the operations of the plant.

A loose piece of board or plank is sometimes found filling in a gap between ladder and runway or runway and structure. A little work will change this dangerous trap to a safe practice.

Before entering any boiler notify the responsible person of your intention; lock all valves leading to the boiler with padlocks and keep the keys in your pocket until you have finished work in the boiler.

Do not allow spare material to accumulate in out-of-the-way places about the room. It is especially dangerous to allow left-overs to accumulate on ledges, tops of boilers, etc. Return all spares to storekeeper.

When a boiler is taken out of commission for repairs or cleaning, the main stop valves in the steam-main connection should be locked with a padlock. After the boiler is drained the blowoff valve should be locked shut.

In case of low water and a hot fire, do not draw the fire with a hoe. If it cannot be dumped into the ashpit, cover it with ashes or coal. Stirring up the fire increases the heat given off. Allow the boiler to cool down before starting the pump or injector.

Safe practices recommend encouragement of firemen and water tenders in removing or minimizing every stumbling hazard in the boiler room. The proper placing of tools in racks, the returning of steam hose and tools to proper places, the piling of fuel and the proper draining of wet places will prevent a great number of boiler-room accidents.—*National Safety Council Leaflet.*

Plan to Build Ships of Concrete

According to *Motorship* there has been considerable discussion in the last year in regard to the feasibility of concrete ships, and now an experiment is to be made and an ocean-going vessel of large size, in this material, is to be thoroughly tried out. Plans for the ship have been prepared by Leroy Caverly, a marine engineer of San Francisco, and if tests now under way are successful, work on the vessel will shortly be commenced. As planned, this experimental concrete ship would be 300 ft. over all, 46-ft. beam, with a depth of 24 ft., and be 5000 gross tonnage and powered by steam turbines of 2500 hp. It is claimed that such a craft would have a dead weight no greater than a wooden vessel of the same size, and can be completed in ninety working days at a cost of only $64 a ton. It is not probable that power will be installed at once, but that the hull will be towed on a test sea trip. The greatest of interest in the project is manifest in San Francisco shipping circles.

Engineering (London) of a recent date contains the following item on the same subject:

"Some few months ago a small company was formed in Hamburg for ferro-concrete shipbuilding, by persons interested in shipping. The system adopted is that of a Herr Rüdiger. The Imperial Dockyard in Kiel has placed with the company a couple of orders for a sea-going lighter of some 300 tons' carrying capacity and a motor cargo-boat. The German Lloyd has investigated drawings and calculations, and has stated its willingness to support this new type of shipbuilding. The Imperial Naval Department in Berlin has also examined the method, with encouraging results, and marine insurance companies have expressed their willingness to insure the ferro-concrete vessels at fair rates. The company is about to build a motor ferro-concrete boat of some 600 tons, fitted with a 300-hp. Diesel engine." *The Steamship* (Leith Scotland) states that a ferro-concrete motor ship, having a tonnage of 600 tons, and measuring 145 ft. in length, with a beam of 27 ft. 6 in., and a depth of 15 ft. 9 in., is now being built in Norway.

Ordinary Hydro-Carbon Oil is most destructive to rawhide pinions, and the fact that rawhide pinions have gained a bad name is entirely due to the use of this lubricant. One of the best compounds for rawhide pinions is given in *Marine Engineering* of Canada as follows: Plumbago, 15 per cent.; resin oil, 55 per cent.; resin, 30 per cent. Cloth and paper pinions can be lubricated without injury with ordinary oil.

New Publications

PRACTICAL MARINE ENGINEERING. By W. F. Durand. Revised and enlarged by Capt. C. W. Dyson, U. S. N. Published by Marine Engineering, 461 Eighth Ave., New York City. Cloth; 6 x 9¼ in.; 982 pages; illustrated. Price, $4.

This is the fourth edition of this excellent work, treating of marine engineering in a practical way. Considerable has been added to bring the subject matter up to date. The book is so well known that a lengthy review is unnecessary. It is one of the best volumes for the practical marine engineer that has come to the reviewer's attention.

SELLING YOUR SERVICES. Published by the Sales Service Co., New York. Size, 8 x 5½ in.; 176 pages. Price, $1.

This is a subject of vital importance, which, unfortunately, many approach in a haphazard manner without first attempting to analyze the situation. To such the book will appeal particularly. It views a man's services in the light of a commodity and applies straight selling methods to the problem. The text is full of trite suggestions, which, if followed, will keep the reader clear of certain pitfalls which it is so easy to run into when seeking employment. Under chapter headings such as "Keep Working," "Know Thyself," "Your Present Employer," "Why Go with a Competitor," "The Personal Call," and "The News Item," many valuable suggestions are given. Much stress is laid on showing the prospective employer that he really needs your services. Typical letters of application are included with ideas for compelling attention. A careful perusal of the book should help the average man in getting into the work for which he is most naturally fitted.

STEAM BOILERS. Revised by Robert H. Kuss. Published by the American Technical Society, Chicago, Ill. Cloth; 138 pages; 8¼ x 5¼ in.; 74 illustrations; indexed. Price, $1.

In the introduction it is stated that "the aim of this little volume is to cover in a very practical manner, and yet with sufficient detail, the methods of construction of the different types of boilers, the proper testing of the materials used, the methods of riveting and staying, and finally a careful discussion of the difficult [different] types of stationary and marine boilers on the market." The book is divided into two parts, Part 1 dealing with the construction of boilers and taking up 56 pages, and Part 2 dealing with types of boilers and taking up 82 pages. Rules are given for testing boiler steel as contained in the Boiler Code of the American Society of Mechanical Engineers. The reviewer is puzzled to know for just what class of engineers the book is intended. Part 1, dealing with construction, is too incomplete to meet the needs of the designer or the constructor, and Part 2 seems to be too much a catalog to command the attention of the designer, although it will, of course, be found useful by the operator.

There is nothing new in the book or nothing that has not been covered by the several books now on the market and dealing with boilers, many of which in new editions have appeared recently. Considering that the volume costs but a dollar, there is everything in it that should be expected for the money.

ELECTRICAL MACHINERY. By Terrell Croft. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City, 1917. Cloth; 5½ x 8 in.; 318 pages; 302 illustrations. Price, $2.

For years a great mass of practical information on the principles, management and operation of electrical machinery has been accumulating in technical papers, books, manufacturers' instruction books, etc., but unfortunately this material has been so scattered that it is was not at the command of anybody. The consolidation of this valuable information into a systematic whole is the latest literary achievement of Mr. Croft. In preparing this book the author has endeavored to include the essential things for the practical man to know about electrical machinery and to omit the nonessentials. Much of the material has to do with the installation, operation, trouble location, etc.

The book is divided into fourteen sections and these sections are again divided into 462 subsections, each subsection is indexed under its title, so that any subject treated is easily found. Section 1 treats of the principles, construction and characteristics of direct-current generators and motors; Section 2, management of direct-current generators, which embraces the parallel operation of various types of two- and three-wire direct-current generators, diagrams of various connections, methods of testing polarity and method of exciting direct-current generators, etc. Section 3 deals with the management of and starting and controlling devices for direct-current motors, including wiring diagrams for different types of direct-current motors connected to hand starters and pressure and pump automatic starters, etc. Section 4 is devoted to troubles on direct-current generators and motors; Section 5, testing of direct-current generators and motors; Section 6, principles, construction and characteristics of alternating-current generators; Section 7, management of alternating-current generators, which gives various schemes of synchronizing to alternating-current generators and wiring diagram for same, methods of phasing out, etc. Section 8 treats of the principles, construction and characteristics of induction and repulsion motors. In this section many diagrams and sectional drawings, showing the wiring and construction of the different types of single-phase motors are given. Section 9 discusses synchronous motors and condensers. Section 10 deals with the management of and starting and controlling devices for alternating-current motors; various compensator and induction-motor starter connections are given, including the wiring diagram for both single- and three-phase pump-motor automatic starters. Section 11 deals with troubles of alternating-current generators and motors; Section 12, testing of alternating-current generators and motors; Section 13, test determination of motor-drive power requirements; and Section 14, motor generators and frequency changers.

Throughout the work 68 formulas are given for working out such problems as every practical man may be called upon to solve in the installation and operation of electrical equipment. To make the formulas easily applied, they are illustrated by a number of examples. Another valuable adjunct to the work is the 302 illustrations. The book does not treat of the design of electrical machinery, since it is intended for the use of the practical man who had to do with the management, installation and operation of electrical machinery, and for this class of readers it contains a wealth of information.

MECHANICAL EQUIPMENT OF BUILDINGS. By Lewis Allen Harding and Arthur Cutts Willard. Published by John Wiley & Sons, New York, 1917. Flexible cover; 7 x 9¼ in.; 766 pages; illustrated. Price, $5 net.

Mr. Harding was formerly professor of mechanical engineering in the Pennsylvania State College and professor of experimental mechanical engineering in the University of Illinois. He is chief engineer and member of the firm of John W. Cowper Co., Buffalo, N. Y. Mr. Willard was formerly assistant professor of mechanical engineering, George Washington University, and sanitary and heating engineer, United States War Department. He is now professor of heating and ventilating at the University of Illinois.

This is the second volume of three that will deal with the mechanical equipment of buildings. The first is devoted to heating and ventilation. The volume under review deals with power plants and refrigeration, and the third volume, now in preparation, will treat of elevators, lighting systems, sprinkler systems, vacuum cleaning and plumbing. In the preface to the present volume, the authors state that it is their object "to produce a reference book for engineers, which will contain sufficient theoretical and commercial data for practical use in the designing room and at the same time serve to show the students of this subject the relation between the theoretical principles involved and their practical application to actual problems."

The reviewer is glad to say this is one of the best books dealing with power-plant engineering that he has had the pleasure of reviewing. The authors are to be commended for the excellent arrangement of the illustrations and text, inclusive of tables, of which there is a very large number, all well selected. The reader will notice that the size is somewhat unusual for a handbook—and the volume is really a handbook—in that the usual handbook size is 4½ x 7 in. The volume deals with physical units and the measurement of each, water, steam and air, fuels and combustion, boilers and rules for construction, including considerable of the boiler code of the American Society of Mechanical Engineers; mechanical stokers, superheaters and economizers, chimneys for power boilers, mechanical draft, feed-water heaters and feed-water purification, steam engines, steam turbines, pumps, steam condensers, cooling towers, pipe fittings, valves, covering and accessories, power-plant piping, the arrangement of steam-power plants, coal- and ash-handling machinery, isolated power-plant data, cost of steam- and gas-power equipment, units employed in refrigeration practice, heat transmission and construction of cold-storage walls, heat transmission of piping as used in refrigeration practice, methods of producing artificial refrigeration, cold-air machines, compression machines, vacuum machines, ammonia condensers, drying circulating systems, the ammonia absorption machines, and ice-manufacturing plants. The foregoing are the chapter headings.

The reviewer finds nothing in the book about which to find fault. He suggests, however, that when Table VII on page 100 is reprinted in the next printing of this edition, the 80 per cent. hard-coal and 20 per cent. soft-coal items in the third column of the table be changed to bituminous, as the stations mentioned therein have not been using this mixture of coal for the last 2½ or 3 years. At present, of course, like all other large users of fuel, they are using whatever they can get.

Chapter 19 on isolated power-plant data will be welcomed by the power-plant engineer, especially the consulting engineer designing such plants, on account of the considerable amount of specific information upon items of capacities and ratios for particular classes of service. In the first paragraph of page 618 the authors say that in the production of power in a steam plant the cost of fuel, using coal, varies from 25 to 30 per cent. of the total cost. The reviewer questions the figures, believing that a more extensive investigation will show that from 40 to 60 per cent. will more correctly cover the various types of plants, and this figure is not based on the present extremely high coal prices.

Chapter 13, dealing with steam condensers, is particularly commendable. The chapter on arrangement of steam-power plants will greatly appeal to the power-plant designer. There are shown in this chapter twenty-four different arrangements as found in plants that have been built.

The authors will probably find that in the next printing it would be well to elaborate more upon the index. The excellent character of the book warrants doing so.

BUREAU OF MINES YEARBOOK

In marked contrast with the ordinary formal official report, the chapter on fuels and mechanical-equipment investigations in the yearbook of the Bureau of Mines (Department of the Interior) is of readable interest and practical value to all concerned in fuel economy and conservation. It is stated that last year 500,000,000 tons of coal was burned, but of this amount the bureau estimates fully 125,000,000 tons, or 25 per cent., was wasted through incomplete combustion and other preventable waste. The function of the Bureau of Mines and the results obtained through its extensive investigations is set forth. We bespeak a closer coöperation between fuel users and this bureau in the interest of economy, and as a means to this end the yearbook can be read with profit.

Personals

Thomas E. Durban has resigned as general manager of the Erie City Iron Works, Erie, Pennsylvania.

Julius Jelenkovski, engineer of the Volga-Kama Association for the Supervision of Steam Boilers at Saratov, Russia, is visiting the United States.

S. L. Nicholson, who has been sales manager of the Westinghouse Electric and Manufacturing Co. for the last eight years, has been appointed assistant to the vice president, with headquarters at East Pittsburgh.

W. L. Barker, electrical engineer of the Southern Utilities Co., has resigned to accept the position of electrical engineer of the Manila (P. I.) Electric Railroad and Light Co. Mr. Barker was formerly connected with the staff of the General Electric Co.

A. B. Elias, formerly division superintendent of plant for the New York Telephone Co., and for the last four years general plant superintendent for the Southwestern Telegraph and Telephone Co., Dallas, Tex., has been appointed general manager of the company, to succeed G. A. Gates, who is vice president.

Prof. L. S. Marks, head of the combined departments of mechanical engineering of Harvard University and Massachusetts Institute of Technology, will assist the National Advisory Committee for Aëronautics in special work of the subcommittee on power plants and will have charge of certain of investigations relating to airplane-engine design conducted at the Bureau of Standards.

Obituary

James Fulton Cummings, an electrical engineer with an international reputation, died on July 26 at Long Beach. Death was due to a stroke of apoplexy received while surf bathing two weeks ago. He was born in London, Ont., 48 years ago. His mother belonged to the Robert Fulton family. Mr. Cummings was associated with Thomas A. Edison for many years and installed the first electric-light stations in Philadelphia, Cincinnati and many other cities. He did similar work in Russian and English cities. He left the Edison Co. in 1893 and went with the General Electric Co. Later he established the Cummings Conduit Co. and built plants at Detroit and Pittsburgh. In 1897 he went to London (Eng.), where he established himself in business. He directed much of the electrical underground-system work in London and other English cities and in 1904 laid the conduits for the great underground system of Petrograd, Russia. He directed similar undertakings in Italy. He retired from business a few years ago and returned to America.

Albert F. Ganz, professor of electrical engineering at Stevens Institute of Technology and well-known consulting engineer, died suddenly from apoplexy on July 29 while on a visit up state. His home was in Hoboken. Professor Ganz was born in Elberfeld, Germany, Apr. 25, 1872, and came to this country with his parents in 1881. Upon graduating from Stevens in 1895 with the degree of mechanical engineer, he was appointed instructor in applied electricity; two years later he was advanced to the position of assistant professor of applied electricity and physics, and in 1902 he was appointed professor of electrical engineering and head of the department. He was widely known in the engineering world, having made many commercial and scientific tests and investigations. He had made a special study of methods for mitigating corrosion of underground structures by electrolysis, upon which subject he was a national authority. Professor Ganz was a fellow of the American Institute of Electrical Engineers and of the American Association for the Advancement of Science, and a member of the following societies: American Society of Mechanical Engineers, American Electrochemical Society, the Society for the Promotion of Engineering Education, Illuminating Engineering Society, American Gas Institute, American Water Works Association, National Electric Light Association, and past president of the New York Electrical Society. He was also a member of the Hoboken Board of Trade, the Engineers' Club, the German Liederkranz of New York, and of the Tau Beta Pi fraternity. He is survived by his widow and two children.

Business Items

The Walworth Mfg. Co. has acquired the Kewanee plant of the National Tube, the latter company having given up the fittings business.

The Everlasting Valve Co. has succeeded the Patterson-Allen Engineering Co., the corporate name not meaning any change in the regular management or business.

The National Mill Supply Co., of Fort Wayne, Ind., has been appointed the exclusive representative for Fort Wayne and vicinity of the Homestead Valve Manufacturing Co., Inc.

The Ross Power Equipment Co. has been appointed Indianapolis representative of the Lincoln Electric Co., of Cleveland, Ohio, with offices at 617 Merchants Bank Building, Indianapolis, Ind.

Robert W. Adams, manager of the Providence (R. I.) office of the General Electric Co., was elected president of the Providence Engineering Society at its recent annual meeting. Mr. Adams is an active member of the Rhode Island Council of Defense and other civic organizations.

The Ingersoll-Rand Co. announces that at a meeting of its board of directors on July 25 J. H. Jowett, formerly general sales manager, was elected vice president of the company, and L. D. Albin, formerly assistant general sales manager, was appointed general sales manager. They will continue to make the company's New York office, at 11 Broadway, their headquarters.

The Coppus Engineering and Equipment Co., manufacturers of power-plant equipment, Worcester, Mass., have purchased property formerly owned by the Hill Drier Co. on Park Ave., consisting of about 1 acre with two four-story brick buildings into which they will move to provide facilities for meeting the increased demand of their turbo forced draft blowers. A new line will also be added to the business.

The United Power and Furnace Co., an Illinois corporation, has been formed to promote economy in the use of coal as a fuel and will be officered as follows: Joseph Harrington, of Chicago, president; William A. Nelson, vice president and general manager; Carl Heim, secretary and treasurer. The company is prepared to design and construct powdered-coal installations, metallurgical and special furnaces, steam-power plants, pumping stations and all apparatus for the economical burning of fuel. As specialists the company is equipped to handle all questions pertaining to fuel economy, particularly the application of powdered coal to malleable- and gray-iron melting, annealing, steel heating, tempering and forging.

Gray & Benjamin is the firm name under which Ainslie Gray and Charles Benjamin have established themselves at technical and trade advertising in the Transportation Building, 608 South Dearborn St., Chicago. Mr. Gray was formerly managing editor of the "Electrical Review and Western Electrician," president of the Federation of Trade Press Associations, and more recently president of the Associated Business Papers, Inc. Mr. Benjamin was in the employ of the old George P. Rowell agency in 1888 and was the first editor of "Printers Ink." He was later with the Century Co.; for nine years advertising manager of the Cutler-Hammer Manufacturing Co., and for the last two years has been engaged in advertising work on his own account.

The Diamond Power Specialty Co. has established at Detroit the first plant devoted exclusively to the production of "Insuluminum" soot-blower units. The process originated and was perfected in the laboratory of the General Electric Co., the latter company having granted to the Diamond Power Specialty Co. the exclusive rights as lessee to its use. The essential point of difference between the effects of this process and any hitherto used commercially, such as galvanizing or sheradizing, is that the insulating material is not imposed as a coating upon the surface of the metal to be treated, but enters into intimate association with it, so that the whole outer region of the body affected changes its composition. A homogeneous alloy is formed, which cannot be destroyed except as the mass of which it is a part is destroyed. The richness of the alloy is proportional to the depth of impregnation, which varies with the length of time of the treatment. It is stated that insuluminum will resist for an indefinite time the continued action of temperatures of the order of 1800 deg. F

Trade Catalogs

Detroit "V" type Stokers. Detroit Stoker Co., Detroit, Mich. Catalog. 6 x 9 in.; illustrated.

Motor-Generator Sets. Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 181. Pp. 8; 8½ x 11 in.; illustrated.

Steel Hoists, Hand Cranes, Steel Trolleys. Wright Manufacturing Co., Lisbon, Ohio. Catalog No. 8. Pp. 32; 6 x 9 in.; illustrated.

Messiter Conveyor Scales. Electric Weighing Co., 180 Thirteenth Ave., New York. Bulletin No. 10. Pp. 20; 6 x 9 in.; illustrated.

Sprague Electric Monorail Hoists. Sprague Electric Works, 527-531 W. 34th St., New York. Bulletin No. 48700A. Pp. 32; 8 x 10½ in.; illustrated.

Superno Steel Superheaters. Superno Co., Inc., 52 Broadway, New York. Catalog. Pp. 32; 6 x 9 in.; illustrated. Line drawings are given showing arrangement of superheaters for various boilers.

Automatic Cut-Off Valves. The Lagonda Manufacturing Co., Springfield, Ohio. Catalog No. 4. Pp. 24; 7 x 10 in.; illustrated. Sectional views and full information regarding operation of valve are given.

Nomenclature of Murray Corliss Engines. Murray Iron Works Co., Burlington, Iowa. Pamphlet No. 7. Pp. 22; 7 x 10 in.; illustrated. By means of sketches the proper names of the various parts of the engine are indicated.

"On the Trail of Byers Pipe." A. M. Byers Co., Pittsburgh, Penn. This is a record of the service given by Byers pipe in plumbing, heating and power stations installed from 25 to 40 years ago. Pp. 40; 4 x 6 in.; illustrated.

"Progress in Water-Works Pumps." De Laval Steam Turbine Co., Trenton, N. J. This is a treatise on the development and advantages of steam-turbine-driven centrifugal pumps for city water supply and contains descriptions of installations in various cities.

Miscellaneous News

The City of Orlando, Fla., is considering the erection of its own water plant to be operated by the city authorities. A committee of three has been appointed to employ a competent engineer to make a survey and ascertain the probable cost of such a plant.

The Metropolitan Electric Co. is to rebuild, at a cost of about $100,000, the electric-power plant at the "Big Dam" at Klapperthal, along the river below Reading, which was destroyed by fire about four years ago. The plant will probably be ready for operation in the fall.

The National Hydro-Electric and Conservation Co., which is constructing a hydro-electric plant at Marble Falls, Tex., has submitted an offer to the city commission of Dallas to supply that city with 20,000 continuous horsepower at one cent per kilowatt-hour for a period of thirty years. The plant will be ready for operation in about eighteen months and will cost about $700,000. The construction of the dam across the Colorado River, which is to form the water-storage reservoir for generating the electricity, was begun several years ago and is expected to develop about 40,000 hp., which will be distributed to cities and towns within a radius of more than 200 miles.

Lighting Rates Based on Fuel Costs— The Bridgeton Electric Co., Bridgeton, N. J., is planning to adopt a new schedule of lighting rates based on the prevailing price of coal for the respective month, and has made application to the State Board of Public Utility Commissioners for permission to make the revision in its present system of charges. The company proposes to take the price of coal at $3.50 per ton as the basis for computation, adding 1 per cent. to consumers' bills for each 10c. additional per ton that the coal may cost at the power plant. As an alternative, the company agrees to deduct a similar percentage for each 10c. a ton below such amount that the price of coal may decline. Holding that the tendency of this change would effect an increase in rates, the utility board has ordered formal hearings to investigate and consider the proposed plan.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Aug. 11, 1917	One Year Ago	Aug. 11, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Aug. 11, 1917	One Year Ago	Aug. 11, 1917	One Year Ago
Clearfields ...	$4.15—4.50	$1.15—1.75	$8.00—8.45	$4.25—5.00
Cambrias and Somersets...	4.40—4.75	1.45—1.90	8.25—8.75	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $5.14—6.50, as compared with $2.85—2.90 a year ago; on cars Boston price is $9.25—9.50.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Aug. 11, 1917	One Year Ago	Aug. 11, 1917	One Year Ago
Buckwheat ..	$4.00—4.25	$2.75	$4.50—5.00	$2.40—2.75
Rice	3.40—3.00	2.25	3.00—3.25	2.10—2.20
Barley	2.90—3.10	1.75	2.50—3.00	1.85—1.95

BITUMINOUS

	F.o.b.	Mine Prices
Bunker coal	$6.25—6.50	.....
Commercial	5.25—6.25*	$3.00 (net)

*Based on Federal Trade Commission suggestion.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Aug. 11, 1917	One Year Ago	Aug. 11, 1917	One Year Ago
Buckwheat ...	$2.90	$1.65	$3.80	$2.55
Rice	2.40	1.00	3.40	....
Boiler	2.20	.90	3.30	1.80
Barley	1.90	.75	2.15	....

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Aug. 11, 1917	One Year Ago
Slack	$3.00—3.25	$0.95—1.00
Mine-run	3.00—3.25	1.35—1.45
¾-in.	3.50—3.75	1.45—1.55

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump ..	$3.25–3.50	$3.00–3.25	$3.25	$3.00–3.25	$3.00–3.25
Lump	3.50	3.50	3.75	3.25–3.50	3.25–3.50
Egg	3.50	3.50	3.75	3.25–3.50	3.25–3.50
Nut	3.50	3.50	....	3.25–3.50	3.25–3.50
No. 1 nut....	3.50	3.50	....	3.25–3.50	.....
No. 2 nut....	3.50	3.50	....	3.25–3.50	.....
No. 3 nut....	3.50	3.50	....	.....	.....
No. 1 washed.	3.50	.....	....	.....	.....
No. 2 washed.	3.50	.....	....	.....	.....
Mine-run	2.75	2.75	3.25	2.50–2.75	2.50–2.75
Screenings	2.75	2.75	3.25	2.50–2.75	2.50–2.75

Hocking lump, $3.75; splint lump, $3.75.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Aug. 11, 1917	One Year Ago	Aug. 11, 1917	One Year Ago	Aug. 11, 1917	One Year Ago
6-in. lump..	$3.25	$1.45	$2.50	$1.25	$2.50	$1.00
2-in. lump..	3.25	1.35	2.25	1.15	2.10	.90
Steam egg...	3.25	1.35	2.25	1.15	2.10	.90
Mine-run ...	2.50	1.10	2.25	1.10	2.00	.90
No. 1 nut..	3.25	1.35	2.25	1.25	2.50	1.00
2-in. screen.	2.50	.85	2.25	.90	1.80	.85
No. 5 washed	2.50	.70	2.25	.70	1.75	.70

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run		Mine-Run
Pratt	$3.50	Carbon Hill	$3.25—3.50
Big Seam	2.75—3.00	Cahaba	3.75—4.00
Black Creek	3.75—4.00		

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Calif., Lancaster—The Southern California Edison Co., of Los Angeles, plans to extend its transmission line from Lancaster into Palmdale and Little Rock. F. P. Pearson, Los Angeles, Supt.

Calif., Los Angeles—The Southern California Edison Co. has been granted permission by the State Railway Commission to issue $10,000,000 in 2-year bonds of which $3,000,000 will be used for building its Big Creek hydro-electric plants and an electric transmission line to Los Angeles. B. F. Pearson, Supt.

Calif., San Francisco—The Great Western Power Co., 14 Sansome St., San Francisco, has been granted permission by the State Railways Commission to build and operate electric transmission and distribution lines throughout Plumas County, except in territory reserved for the Grizzly Electric Co. E. N. Beardsley, Gen. Supt.

Fla., Orlando—City plans to install an electric-light and water-supply plant. F. H. Williams, Clk.

Ill., Bethany—City plans election to vote on bonds to install new equipment in city light plant.

Ill., Palmyra—The Palmyra Light, Heat and Power Co. recently organized with $10,000 capital stock has applied for incorporation papers and plans to generate and supply light and power by electricity or steam. L. King and C. W. King and others are the incorporators.

Ind., Ft. Wayne—The Ft. Wayne & Northern Indiana Traction Co., 310 West Main St., plans to build an addition to its power house on Spy Run Ave. Estimated cost, $85,000. E. S. Myers, Supt.

Iowa, Manchester—City plans to install an electric-light plant.

Iowa, Sioux City—The Sioux City Gas and Electric Co. plans to build a steel and frame addition to its power plant. Estimated cost, $200,000. O. W. Harrod, Engr.

Kan., Atwood—City voted $20,000 bonds to improve electric-light plant. Improvements include extension of transmission lines and the purchasing of a large engine and generator.

Kan., Cherokee—The Kansas Gas and Electric Co., 237-9 South Main St., Wichita, plans to build an electric transmission line from Cherokee to Cherryvale. The company has applied to the county commissioners for permission to build a line from Cherryvale to Labette County line. J. M. Strike, Engr.

Kan., Luray—City voted $20,000 bonds to build complete new electric-light plant. W. W. Brumfield, City Clk.

Md., Baltimore—The Baltimore Dry Dock and Shipbuilding Co., Locust Point, is having plans prepared for a 1-story, 70 x 90-ft. power house.

Md., Cecilton—W. H. Alderson and associates are organizing a company and plan to build and operate an electric-power plant for power service in this section.

Neb., Ogallala—City voted $10,000 bonds to install an electric-lighting system.

Nev., Yerrington—The Kennedy Consolidated Mines Co. is having plans prepared for the installation of electric-lighting plant.

N. J., Elizabeth—The Diehl Manufacturing Co., Trumbull St., manufacturer of electrical apparatus, plans to build an addition to its plant.

N. Y., Buffalo—The Buffalo General Electric Co. has issued $4,000,000 in bonds to be used for extensions. Plans include the building of a steam generating plant outside of Buffalo. P. F. Sellers, Gen. Supt.

N. Y., Newton Falls—The Newton Falls Paper Co. plans to build a new hydro-electric power plant to develop electric power for works operation. Estimated cost, $50,000. C. E. Easton, Sherman Blk., Watertown, Engr.

N. Y., Solvay—The Solvay Process Co. plans to build an addition to its boiler house and will install 2 additional units.

N. C., Oriental—The Town Council plans to issue bonds to install an electric-light plant.

Ohio, Cleveland—The City Commissioner of purchases and supplies, City Hall, is receiving bids until Aug. 21 for furnishing transformers for the Division of Light and Heat.

Ohio, Columbus—The Ohio University Trustees will receive bids Sept. 4 for a new powerhouse to be built on the university grounds. Estimated cost, $120,000.

Okla., Tulsa—The Public Service Co. plans to improve its local power plant. Estimated cost, $15,000. E. C. Hughes, Engr.

Ont., Toronto—The J. Inglis Co., 14 Strachan Ave., plans to build a power house. Estimated cost, $5000.

Penn., Mercer—The Mercer County Comrs. plan to build a power house and heating plant.

Tex., Cisco—The Cisco Gas and Electric Co. plans to improve its plant. Plans include the installation of a new boiler, lightning arresters, etc. G. Beer, Mgr.

Tex., El Paso—The El Paso Valley Water Users Assn. plans to build a hydro-electric plant at the Elephant Butte Dam with 40,000 hp. capacity. Estimated cost, $1,000,000.

Va., Atkin—The Norfolk & Western R.R. plans to build a power plant. J. E. Crawford, ch. engr.